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Tables of Locomotive Dimensions

In this issue will be found a tabular comparison of the dimensions of the various types of passenger locomotives covering the Mountain, Pacific, Prairie, Atlantic and ten-wheel types, as well as the mogul and switching types. The tables for the Mallet, Santa Fe, Mikado and consolidation types will appear in the February issue. As it is impossible to publish descriptions of all the latest and best examples of all the different types of locomotives in these columns, in many cases selections have been made from the 1912 edition of the Locomotive Dictionary for the typical examples presented, particularly those of the smaller and lighter types. It will be noted that several new ratios are given. These include the percentage of weight on drivers, the amount of evaporative heating surface per square foot of superheater heating surface and the ratio of the firebox heating surface to the grate area. It is believed that each of these is of value in outlining a design to meet specified requirements.

Standard Locomotives of the Associated Lines

In 1903 the Union Pacific System—Southern Pacific Company, then known as the Harriman Lines, adopted a series of standard locomotive designs covering all the different sizes and types that the service demanded. These standards were followed with but minor alterations for seven or eight years and, with the exception of the adoption of the Walschaert valve gear and the installation of superheaters on most of the original classes, are in force today. There is no doubt in the minds of those familiar with all of the conditions but that the close adherence to the standard locomotive designs has been most profitable, and that it is to a considerable degree responsible for the very satisfactory operating expense ratio that has been consistently exhibited on these lines. As was expected in the beginning, it was found necessary after five or six years, to add new and larger classes to the list of standards, and, as will be seen by reference to the article on page 5, the motive power of these lines has not suffered in size, range or efficiency by any fancied restrictions of the standards.

Errors in Locomotive Design

In the design of railroad equipment, and particularly in the case of locomotives, it is often difficult to best proportion and locate a part for the duty it has to perform, and at the same time have it readily accessible and removable for repairs. The latter is, however, a point which should receive more attention at the hands of the designer than it would seem to in many cases. Bolts are very frequently located so that it is next to impossible to remove the nuts, or the bolt after the nuts are removed. Driver brake cylinders are found on modern locomotives so located that it is impossible to remove the piston and spring without taking down the entire cylinder at a cost of several hours extra labor, and in some of the older moguls and consolidations it is impossible to remove the wrist pin from the crosshead without jacking up the engine. Admittedly there are many cases where the question of convenience has to be set aside for some other more pressing consideration of design, but there can be no doubt that more careful consideration of this point in the drawing office would frequently result in considerable saving in the shops and engine houses, and in the reduction of the time that power is out of service.

Car Testing Plant

A report of experiments on the performance of freight car trucks under varying conditions common in actual service will be found on another page. Important data have been obtained which should materially guide the builders and maintainers of car equipment in their future work. This was all done by a mechanical expert under the auspices of a railway supply concern. We cannot discredit any part of the information

as advertising matter. All we can say is that if the data obtained had not been in accordance with the supply company's ideas it might not have been published. We have a sort of neutral ground for testing locomotives at both the University of Illinois and at Purdue University, and also for conducting certain tests for the Master Car Builders' Association. Why should not the railroads get together and establish a testing plant for locomotives, cars and other equipment? They do support an association that constantly investigates the design, control, interchange standards, etc., of cars, but its work is limited because of the lack of proper facilities for making what might be called laboratory tests where all the conditions can be controlled, as distinguished from service tests. That such a testing plant would pay for itself there is no question, for there are vital problems constantly arising, which if properly and correctly solved would mean a considerable saving to the railroads, to say nothing of the increased safety in design. Such questions as tender derailments, the maximum life of wheels, proper design of trucks and underframes, the most economical and durable design of freight car superstructure and various other problems could be investigated.

Large Capacity Freight Cars

For nearly ten years 100,000 lbs. has been the generally adopted capacity for gondola and hopper cars and with the exception of a few special service cars of various types, a car of larger capacity than 120,000 lbs. has been a novelty. While, as a general rule, it can be stated that for this type of car the larger the capacity the greater the proportion of revenue load on a fully loaded car, and, that on those roads having a continuous traffic of mineral products, the demand for larger cars has existed for some time, it has seemed undesirable to perfect a freight car wheel and axle suitable for the heavier pressures that would result if the four-wheel truck was to be retained. The meeting of the demand, therefore, has largely depended on the development of a satisfactory six-wheel freight car truck. The normal type of six-wheel passenger car truck is too heavy, too complicated and too expensive for this service. The building of a suitable car body for this capacity presents no serious problems. Among the roads having a heavy coal traffic is the Norfolk & Western. The mechanical department officers of that road undertook the work of designing a ninety-ton gondola car and have built such a car which is fully illustrated in this issue. The six-wheel truck is entirely original and would appear to have gone a long way toward the solution of the problem. It weights less than 15,000 lbs., uses the standard 5½ in. x 10 in. axle, has forged steel wheels and cast steel side frames. The novel construction of side frames has avoided the use of equalizers or pedestals and the journal boxes are bolted directly to the frame in the same manner as on a four-wheel freight car truck. The incorporation of a hinged joint over the center journal box makes the frames act as equalizers and there would appear to be but little doubt that the distribution of weights and the flexibility of the truck will be satisfactory. The car body is of the continuous center sill type and is to be used with an unloading machine. For this reason and also to prevent bulging under load, the sides have been unusually well stiffened by wing plates.

Car Department Competition

Last month we made the first announcement of a car department competition to close February 15, 1913. A canvass of our subscribers shows that there is a considerable demand for a larger amount of material of special interest to car department readers. Apparently the fact that the men in this department have not contributed to our columns as freely as those in the locomotive department, or have not been as free in making suggestions or criticisms, is not due to any lack of interest or to indifference. To encourage those who are interested in the design, construction, or maintenance of cars to contribute more freely to our columns we announced last month that a first prize of $50 would be awarded for the best article received before February 15, 1913, dealing with some subject of prime interest to those who are interested in the work of the car department. The conditions have been made as broad as possible in order that our car department readers generally may have an opportunity of competing. For instance, the car designer may make suggestions either as to the design of detail parts or of the cars as a whole. The men who are engaged in the construction of the cars may direct attention to methods or devices which are an aid in their work, or may suggest to the designer how he may assist them in securing better results. The men who are engaged in repairing and maintaining the equipment can tell how this may be performed to the best advantage by either describing the methods in use, the appliances which it is best to use, or going into other details in which they are specially interested. In many cases they can make valuable suggestions to both the designer and constructor as to the reduction in expense of maintenance or better protection to the material which is transported in the cars, which may be made possible by improving their methods or modifying the design. These are only a very few suggestions. There are hundreds of other subjects which are of equal interest and which if properly handled will prove of great interest and value to the car department at large. In periods of heavy traffic and congestion, such as we are now experiencing, it is of vital importance that every piece of equipment be available for service as great a proportion of the time as possible, and it is at times like these that the weaknesses in the equipment are most evident. What are these weaknesses and how may they be overcome? What steps should be taken to keep the cars off of the repair track, and, if it is necessary for them to go there, what methods and devices may be used for getting them back into service at the earliest possible moment? In addition to the first prize of $50 for the best article, any other articles accepted for publication will be paid for at our regular space rates.

The Mechanical Engineer

In a paper on "Specifications," presented before the Western Railway Club, December 17, 1912, by O. S. Beyer, Jr., the statement was made that the preparation of good, thorough specifications is the duty of the mechanical engineer and his staff, collaborating with the engineer of tests and the practical men in the field. This is undoubtedly desirable, but there are many conditions which tend to work against its obtaining in practice, even on the larger roads. As stated in the paper, limitation of staff is one of the most serious drawbacks, and the savings that can be effected by a properly equipped and organized drawing office are generally of such a nature that they cannot be shown in concrete form and thus used as an argument against an increased first cost resulting from adequate specifications.

There have been, and unfortunately still are, many higher officers who do not seem able to see beyond the question of first cost, and the idea of increasing the first cost a little in order to save on maintenance charges is to them a question entirely outside the limits of consideration. Recently, however, there has been a decided move away from this position, and more and more railroad officers have awakened to the fact that equipment properly designed and built from proper material will result in decreased maintenance charges and claims for damaged freight. This can hardly result otherwise than in greater recognition of the mechanical engineering staff and in its being placed on a higher plane.

Instances have not been altogether unknown in which the mechanical department has been overridden in the purchase of power by a general manager or a vice-president who had in mind only the increase of train loads. This has resulted in some roads being saddled with large engines which were entirely beyond the shop and engine house facilities, resulting in enormous increases in maintenance charges. All things considered, however, there is no doubt but that the mechanical engineer and his staff have

made great progress in the past few years toward the position which they should hold in a railroad organization, although this place is not yet by any means attained.

There are two considerations which work against the mechanical engineer, not only as regards the use of proper specifications but against engineering matters as a whole. One of these is that very frequently locomotives and cars are needed in such a hurry, in order to take care of a rush in business, that all engineering considerations have to be thrown aside and the road takes what it can get. The other is the question of friendship and favortism between some railroad officers and supply men. That weeks and months of patient work in the mechanical engineer's office may frequently come to nothing because of an order for equipment being given to some friend of an official is a disgraceful condition, but it is nevertheless one which still exists and should be dealt with vigorously.

Cars and Locomotives in 1912

According to statistics published in the *Railway Age Gazette* there were 4,515 locomotives ordered during 1912 or nearly 60 per cent. more than in 1911. In the accompanying table the locomotives ordered for the two years are shown as grouped in classes together with the number fitted with superheaters in each year. The superheaters include devices giving either a high or low degree of superheat. It will be seen that 60 per cent. of the steam locomotives ordered in 1912 were fitted with superheaters as compared with only about 38 per cent. of those ordered in 1911. Of the different types ordered during the year the Mikado or 2-8-2 type is in the lead, and comprises 29 per cent. of the total number of locomotives and 29½ per cent. of the total number of steam locomotives. In 1911 this type was also in the lead, but was much more closely approached by the consolidation which this year is again second but with a reduced percentage. In 1911 there were about thirteen less consolidations ordered that Mikados, while in 1912 there were 451 less. An examination of the percentages of the other types shows that there has been comparatively little change in the demand for each with the exception of the American or 4-4-0 type and the Mogul or 2-6-0 type. In both years all of the locomotives of the Atlantic type reported were confined to two railways, viz., the Philadelphia & Reading and the Central Railroad of New Jersey. Of the American type, the eight ordered this year were in each case single locomotives for private lines or unimportant branches. In 1911, however, the twenty-seven of this type ordered included twenty-one for four trunk line railways. It is evident that the American, Atlantic and Mogul types have been practically superseded by other types for new power. This table does not include the experimental Atlantic type engines built by the Pennsylvania which indicate that the possibilities of this wheel arrangement have been by no means exhausted and that it can be made to satisfactorily perform a range of service which it has been generally believed required the use of a Pacific type. While as a coal burner the Mogul is probably superseded for trunk line service, when arranged for oil burning this type has possibilities which should not be overlooked. The same statement also applies to the American type.

	1912.		1911.		1912.		1911.	
Type.	Number Ordered.	Per Cent. of Total.	Number Ordered.	Per Cent. of Total.	Having Superheaters.	Per Cent.	Having Superheaters.	Per Cent.
Mikado	1,309	29.0	590	20.7	922	70	306	52.0
Consolidation	858	19.0	577	20.2	552	64	223	39.0
Switching	821	18.2	443	15.5	322	39	26	6.0
Pacific	594	13.2	486	13.2	432	73	255	52.5
Ten-wheel	364	8.0	238	8.4	297	82	112	47.0
Mallets	168	3.7	112	3.9	106	63	66	59.0
Mogul	61	1.35	127	4.45	11	18	3	2.5
Electric	75	1.65	133	4.65	...	...	...	...
Shay	23	.51	15	.52	...	...	...	...
American	8	.18	27	.95	0	0	0	0
Atlantic	5	.11	9	.33	5	100	9	100
Others	229	5.1	93	3.3	5	2.2	37	40
Total	4,515	100	2,850	100	2,652	...	1,037	...

Seventy per cent. of the Mikados, seventy-three per cent. of the Pacifics and eighty-two per cent. of the ten-wheelers ordered this year were fitted with superheaters. Comparing this with the percentages of the year previous, the present status of this economizer is clearly indicated. When it is stated that 60 per cent. of the locomotives ordered this year have superheaters it must be remembered that there are included in this 229 locomotives which are grouped under the classification of "other types," and include geared, contractor's and various odd or unusual wheel arrangements, usually of a small size. When these are excluded, this percentage is raised to nearly 63. Probably the most striking figure in this part of the table is in connection with the switching locomotives of which 322, or 39 per cent. of the total number ordered, are to be fitted with superheaters. It is evident that the value of the superheater for this service, which has been largely proved during the past year, is being generally realized.

During the year there were 234,757 freight cars and 3,642 passenger cars ordered from the builders or from the shops of the various railways. Of these 107,887 or 46 per cent. were box cars, 74,505 or nearly 32 per cent. were coal cars and 19,720 or about 8½ per cent. were refrigerator cars. The remainder consists of 12,616 flat cars, 4,951 stock cars, 1,918 tank cars and 13,161 miscellaneous cars. While the statistics show that the wooden freight car is still being built in small numbers, the all-steel or steel underframe car has become almost standard practice. One hundred all-steel box cars were ordered by the Bessemer & Lake Erie during the year and other railways have also ordered experimental equipment of the same type. Experience with all-steel box cars covering several years seems to indicate that the fears of a collection of moisture on the inner face of the sheets with sudden changes of temperature are groundless and that good ventilation will overcome any difficulties of this kind.

While the statistics of passenger cars are not as complete in regard to details of construction as are those on freight cars and locomotives, they show that at least 52 per cent. of the passenger equipment ordered during 1912 was of the all-steel type and nearly 14 per cent. had steel underframes. Practically all of the equipment that has been ordered for use on main lines is included in these classifications. The other cars are largely for the shorter branch lines and the minor railway companies. It is probable that nearly all of the equipment ordered for use in heavy passenger train service is of the all-steel type.

Selection of a Locomotive

The locomotive was considered from a broad engineering standpoint, probably for the first time at any similar meeting held in this country, at the Railroad Session of the American Society of Mechanical Engineers, held on December 5. The paper presented for discussion was by O. S. Beyer, Jr., and was entitled, "Factors in the Selection of Locomotives in Relation to the Economies of Railway Operation." An abstract of the paper and of the discussion is given in this issue. Mr. Beyer was able to but briefly refer to the many conditions that must be considered in designing a new type of locomotive if it is to be perfectly suited for a particular service. Many of these conditions are conflicting and often a compromise must be effected. No definite recommendations were made by the author who confined his remarks to simply pointing out what conditions should be considered.

There is one controlling factor which should determine the design of a new locomotive and that is net cost. It is well known that the large modern locomotive will handle very large trains with a decided reduction in the cost per ton-mile and per ton-mile per hour. But it is also well known that the cost of maintaining these larger locomotives is considerably greater and it is by no means proved that they will operate at the same relative efficiency when considerably underloaded. Thus there arises a question if it is not the wiser and more economical plan to decide on a series of standard locomotives which will be used without material

change for a reasonable number of years rather than to redesign each new lot ordered. The total cost of maintenance is effected very materially by the number of different types and classes in use. Furthermore, as was mentioned by Mr. Vaughan in discussing this feature, the motive power of a road having standards is much more flexible and can be shifted from one part of the system to another without raising the cost of repairs and without crippling the service due to holding an engine in the shop while awaiting the arrival of some necessary part. It has been the experience of those roads that have gone into standardization of motive power most extensively that there need be no reduction of development or experimental work, but that it has been necessary and normal to add a new type or class to their classification every three or four years which, however, will use many of the parts common to other locomotives. It seems that the principal difference between those roads provided with complete standards and others not so provided is that the former spend several years in experimental and development work and finally determine on a thoroughly well fitted design which is decidedly larger and more powerful than the previous standard engines for the same service, while the latter, meanwhile, may have purchased a number of different designs each of which may have been best suited for a particular condition existing at that particular time, and at the end of five or six years they have comparatively small numbers of many different classes scattered over the system. From the standpoint of net cost of furnishing transportation it would seem that the standard locomotives which are best suited to the average conditions of service will prove better than those which are especially designed for some local condition which may change even before the engines have passed their first shopping. In speaking of standard locomotives in this connection it is not to be inferred that a standard design is inviolable simply because it is standard, but it does imply that only such changes are to be made in which the new design will replace a part in such a way as not to affect the other standard parts.

One of the notable events of the year in locomotive design is the demonstration of the possibilities of the Atlantic type locomotive by the Pennsylvania Railroad. The experimental engine built for this purpose carries the largest weight per driving axle of any in this country. But, as was pointed out by Mr. Gibbs in the discussion, it is not the static wheel load alone that should be considered, but the dynamic plus the static. If the weight of the reciprocating parts can be sufficiently reduced there is no objection to raising the wheel load. W. F. Keisel, Jr., in his discussion stated that it will be possible to use a weight of 70,000 lbs. per pair of drivers if the weights of the reciprocating parts are sufficiently reduced. A number of years ago the Master Mechanics' Association adopted a rule for counterbalancing, proposed by G. R. Henderson, in which it was stated that the equivalent of the weight of the locomotive divided by four hundred, in weight of reciprocating parts, could be left unbalanced. If the counterbalance weights on each pair of wheels are carefully weighed this rule is satisfactory. It was stated by Mr. Keisel that one pound of reciprocating weight to each hundred pounds of maximum piston pressure is within the bounds of possibility. This, in connection with Henderson's rule, for Atlantic type locomotives would permit the use of counterbalances for reciprocating parts equal to one-third their weight. If this point is reached a weight of 70,000 lbs. per axle will put no more strain on the rail than is induced by the heavy locomotives now in service where the counterbalance weights are generally two-thirds of the weight of the reciprocating parts.

While the experimental locomotive does not quite reach this weight per driving axle, it carries an unusually large boiler having tubes 13 ft. 9 in. in length and is fitted with a high degree superheater. On the testing plant it gave a maximum indicated horsepower of 2,355, and when operating at a horsepower of over 2,000, a minimum steam consumption of 16 lbs. per horsepower hour was attained. The maximum equivalent evaporation of the boiler was 16.9 lbs. per sq. ft. of heating surface per hour. These tests indicate the possibility of one horsepower per 100 lbs. of weight, or for 1⅓ sq. ft. of heating surface at 80 miles per hour. The results from this locomotive indicate the better engineering which the past year has shown is beginning to be applied to the locomotive as a whole. Locomotive No. 50,000 designed by the American Locomotive Company, was a revelation of what could be done with a Pacific type by careful attention to proportions and of better engineering in the design of various parts. The Atlantic type on the Pennsylvania goes a step further in the same direction. With these as an example it is probable that the coming year will bring forth further surprising results in the capacity of locomotives that are within the normal clearance limits.

It is but beginning to be understood how little is really known of the processes of combustion in a locomotive and the ways of improving it. The firebox end of a locomotive presents a rich field for investigation. With all these possibilities of improvement in mind, the difficulties of determining the design of a series of standard locomotives are great and in preparing the designs it should be kept clearly in mind that it may be desirable to replace various parts or even a complete boiler within a few years. Such alterations, however, by no means interfere with the maintenance of the standards as the term should be applied to locomotives.

NEW BOOKS

Master Car and Locomotive Painters' Association. Proceedings of the 1912 Convention. Bound in cloth. 108 pages. 6 in. x 9 in. Published by the Master Car and Locomotive Painters' Association of the United States and Canada, A. P. Dane, Secretary, Reading, Mass.

The forty-third annual convention of this association was held in Denver, Colo., September 10-13, 1912. The most important subjects considered were the Finish of the Vestibule Ends; the Report of the Test Committee, which contained valuable information on turpentine substitutes; the Essentials of a Protective Paint-Making Oil; the Use of Interior Car Renovators; the Most Economical Method of Removing Paint from Locomotive Jackets; the Care of Steel Passenger Car Roofs; the Treatment and Finish of Passenger Car Floors; and the Modern Method of Exterior Passenger Car Painting.

Investigation of Explosion Proof Motors. By H. H. Clark. Illustrated. Bound in cloth. 44 pages. 6 in. x 9 in. Published by the Bureau of Mines, Department of the Interior, Washington, D. C.

This pamphlet contains a detailed account of the apparatus used in the tests and the method of testing motors to determine their tendency to cause mine explosions. The term "explosion proof," as applied by the Bureau of Mines to an electric motor, refers to a motor enclosed by a casing so constructed that an explosion of a mixture of mine gas and air within the casing caused by a spark in the motor will not ignite a mixture of the same gas surrounding the motor. Various mixtures of gas were used in the test under various pressures and explosion indicator cards are shown for a number of the tests.

Hygiene for the Workers. By William G. Tolman, Ph.D., Director American Museum of Safety, New York City, and A. W. Guthrie, Department of Research, American Museum of Safety. Illustrated. Bound in cloth. 231 pages. 5½ in. x 7½ in. Published by the American Book Company, New York. Price, 50 cents.

This book is thoroughly practical. In addition to the general topics treated, such as clothing, food and exercise, the subjects of alcohol, tobacco and anti-tuberculosis measures, home hygiene, and the particular necessities for cold and hot weather are considered. The work is divided into 19 chapters, which not only deal with the clothing, cleanliness and general good health from a hygienic point of view, but also from the inherent value it is to a person in the business world. Among the characteristic chapters are: Applying for a Position, Good Habits for the Worker, Food and Drink, Hygiene of the Work Room, After Hours, Choice of an Occupation, First Aid to the Injured, Seasonable Hygiene, etc.

LOCOMOTIVES FOR THE ASSOCIATED LINES

Common Standard Designs Changed to Include the Walschaert Valve Gear and Superheaters.

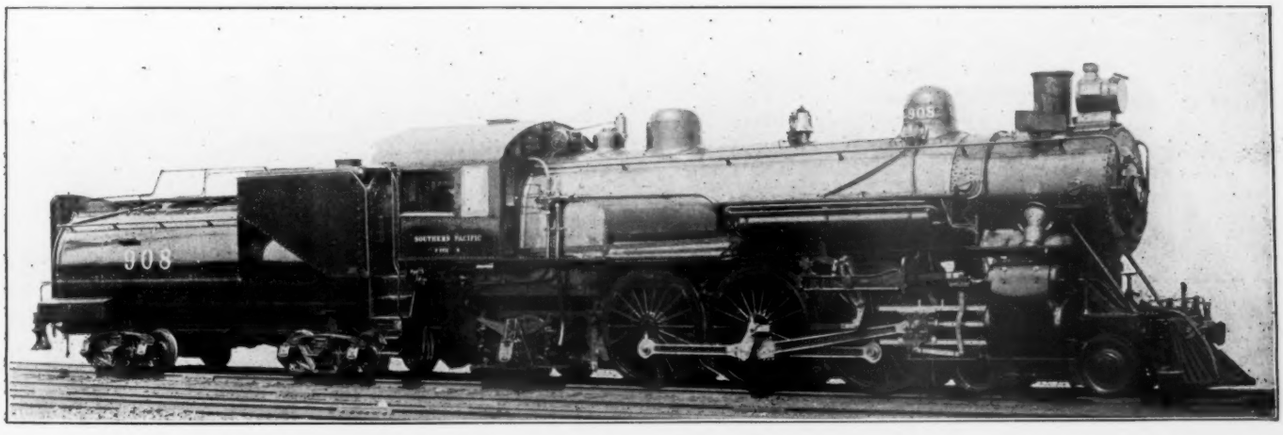
Between 1903 and 1906 the Union Pacific System-Southern Pacific Company, commonly known as the Associated Lines, adopted a series of standard locomotives which included engines of the Atlantic type, Pacific type, ten-wheelers, consolidations, moguls and six wheel switchers. No radical changes or additions were made to these locomotives up to 1909, when two classes of Mallets were designed and put in operation. One of these was a very heavy 2-8-8-2 type and the other a 2-6-6-2 type for freight service. Both of these engines were intended primarily for the Southern Pacific Company and were oil burners.

In the following year several more classes were adopted; these included a Mikado freight locomotive, a Mikado passenger loco-

GENERAL DIMENSIONS AND RATIOS OF SOME OF THE COMMON STANDARD LOCOMOTIVES FOR THE ASSOCIATED LINES.

Type	2-8-8-2	2-6-6-2	2-8-2	2-8-2	4-6-2	4-6-0	2-6-0	0-6-0
Service	Freight	Pass.	Pass.	Freight	Pass.	P. & F.	Freight	Switch
Fuel	Oil	Oil	Lignite	Coal	Oil	Oil	Oil	Coal
Tractive effort, lbs.	94,640	74,000	51,100	45,300	29,900	36,600	33,300	27,300
Weight in working order, lbs.	436,200	389,000*	285,000	265,700	221,100	208,750	179,750	145,700
Weight on drivers, lbs.	400,900	323,000*	214,000	206,500	141,500	162,500	151,050	145,700
Weight on leading truck, lbs.	17,900	33,000*	25,000	24,800	37,600	46,250	28,700	.....
Weight on trailing truck, lbs.	17,400	33,000*	46,000	34,400	42,000	.....	.....	.....
Weight of engine and tender in working order, lbs.	620,000	572,800	456,500	433,000	382,000	346,000	343,000	230,000
Wheel base, driving, ft. & in.	39—4	11—0	16—6	16—0	13—4	13—10	15—2	11—0
Wheel base, total, ft. & in.	56—7	51—4	35—2	34—8	33—4	25—10	24—0	11—0
Wheel base, engine and tender, ft. & in.	90—4	85—1	65—1¼	64—7⅜	68—6¼	58—¼	58—8¾	42—8¼
RATIOS.								
Weight on drivers ÷ tractive effort	4.33	4.37	4.18	4.57	4.72	4.45	4.55	5.34
Total weight ÷ tractive effort	4.61	5.25	5.58	5.85	7.36	5.71	5.40	5.34
Tractive effort × diameter drivers ÷ heating surface	959.00	841.00	763.00	617.00	870.00	960.00	1,112.00	896.00
Total heating surface ÷ grate area	82.30	59.90	60.10	57.00	53.60	75.00	38.50	51.50
Firebox heating surface ÷ total heating surface, per cent	4.26	5.58	5.68	5.00	6.80	9.20	8.00	9.00
Weight on drivers ÷ total heating surface	72.80	76.60	50.60	49.50	53.50	67.60	80.40	93.50
Total weight ÷ total heating surface	77.50	92.10	67.50	63.50	83.40	87.00	95.40	93.50
Volume both cylinders, cu. ft.	27.00	25.00	17.20	15.40	12.32	12.32	11.20	8.52
Total heating surface ÷ volume cylinders	208.00	168.00	246.00	272.00	216.50	195.00	168.00	183.00
Grate area ÷ volume cylinders	2.54	2.81	4.09	4.76	4.01	2.60	4.42	3.54
CYLINDERS.								
Diameter, in.	26 & 40	25 & 38	26	23¾	22	22	21	19
Stroke, in.	30	28	28	30	28	28	28	26
WHEELS.								
Driving, diameter over tires, in.	57	63	63	57	77	63	63	51
Driving journals, main, diameter and length, in.	11 x 12	11 x 12	10½ x 12	10½ x 12	10 x 12	10 x 12	9 x 12	9 x 12
Driving journals, others, diameter and length, in.	10 x 12	10 x 12	9 x 12	9 x 12	9 x 12	9 x 12	9 x 12	.....
Engine truck wheels, diameter, in.	30½	30½	30¼	30½	33½	30½	30½	.....
Engine truck, journals, in.	6 x 10	6 x 10	6 x 10	6 x 10	6 x 10	6 x 10	6 x 10	.....
Trailing truck wheels, diameter, in.	30½	.....	36	36	45	.....	.....	.....
Trailing truck journals, in.	6 x 10	.....	8 x 14	8 x 14	8 x 14	.....	.....	.....
BOILER.								
Style	Str.	Str.	Str.	Str.	Str.	W. T.	W. T.	Str.
Working pressure, lbs.	200	200	200	180	200	200	200	175
Outside diameter of first ring, in.	84	80½	82	82	70	72	70	65
Firebox, length, in.	126	120⅝	120⅝	120⅝	108	124	108	108
Firebox, width, in.	78¼	84	84	84	66	37¼	66	40¼
Firebox, water space, in.	5	5	5	5	5	5	5	4 & 3½
Tubes, number and outside diameter, in.	250—2¼	275—2	275—2	275—2	173—2	204—2	193—2	237—2
Flues, number and outside diameter, in.	36—5½	36—5⅜	36—5⅜	36—5⅜	24—5⅜	28—5⅜	26—5⅜	.....
Tubes, length, ft. & in.	21—0	20—6	20—6	20—6	20—0	15—0	12—8	11—6
Heating surface, tubes, sq. ft.	4,164	3,973	3,973	3,973	2,477	2,181	1,734	1,417
Heating surface, firebox, sq. ft.	240	235	240	208	181	221	151	140
Heating surface, feed water heater, sq. ft.	1,222	1,336	.....	.....	.....	.....	.....	.....
Heating surface, total, sq. ft.	5,626	4,208	4,213	4,181	2,658	2,402	1,885	1,557
Superheater heating surface, sq. ft.	900	865	880	895	580	483	417	.....
Grate area, sq. ft.	68.4	70.4	70.4	70.4	49½	32.1	49.5	30.2
TENDER.								
Tank	Semi-cyl.	Semi-cyl.	Water Bot.	Water Bot.	Vanderbilt	Vanderbilt	Vanderbilt	Sloping
Wheels, diameter, in.	33	33	33	33	33	33	33	33
Water capacity, gals.	9,816	9,816	9,000	9,000	9,000	7,000	9,000	4,000
Coal capacity, tons	3,120 g.	3,120 g.	15	15	2,940 g.	2,940 g.	2,940 g.	6

*Estimated.



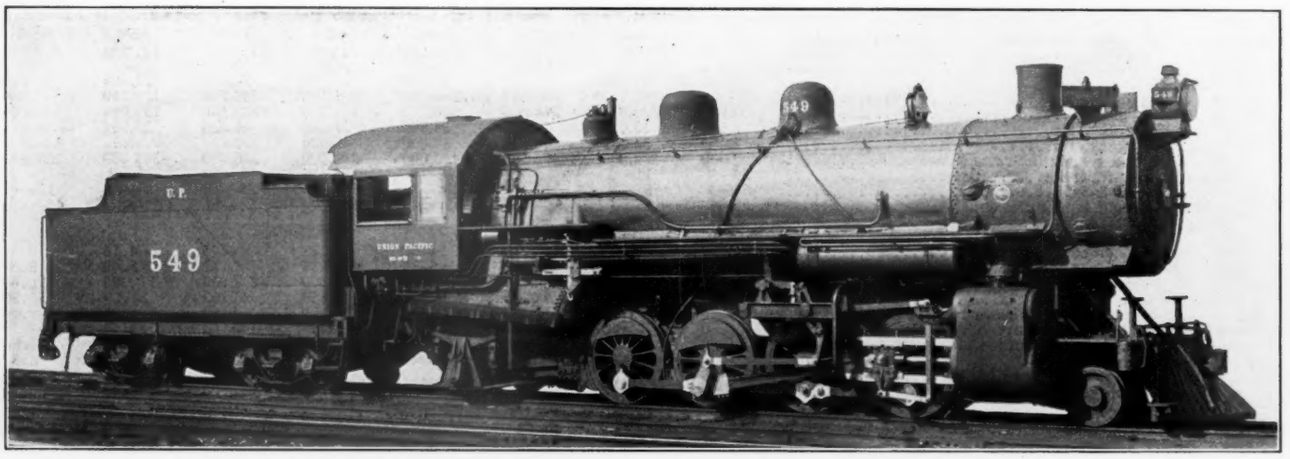
Standard Light Pacific Type Locomotive for the Associated Lines.

motive and a heavier Pacific type. During this year there was also designed an oil burning locomotive of the eight wheel type which has 100,000 lbs. on drivers, 20 in. x 26 in. cylinders and 73 in. driving wheels. A somewhat more powerful 2-6-6-2 type passenger locomotive was also built that year and the Mallet 2-8-8-2 type design was revised. The passenger engines were arranged to run with the cab ahead.

Meanwhile the original standards were maintained and additional locomotives were purchased with but minor alterations, as the service demanded. During 1911 and 1912 changes were made in all designs which had not been previously fitted with the Walschaert valve gear, and this gear is now standard on all locomotives with the exception of the consolidation and Atlantic types. The boilers have been arranged to permit the application of high degree superheaters in practically all classes that are now being built.

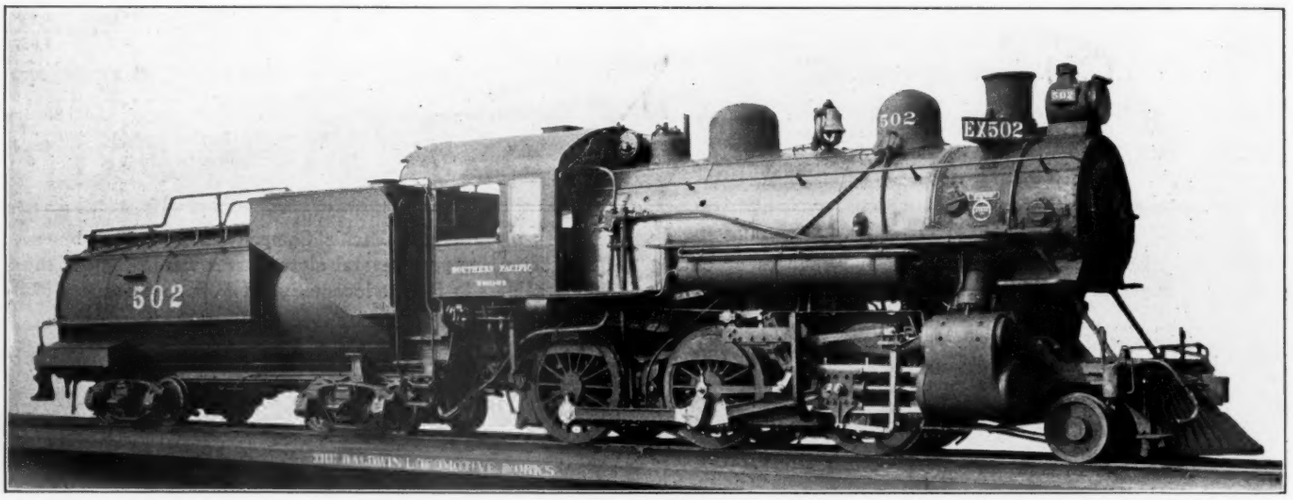
The common standard types of locomotives at present are therefore the original Atlantic and consolidation types with Stephenson valve gear and without superheaters; the original six wheel switching type to which the Walschaert valve gear has been applied; light and heavy Pacific types with Walschaert valve gear and superheaters; two classes of ten wheelers, one for oil burning with a narrow firebox and the other with a wide firebox for coal burning, the latter being built with either 63 in. or 69 in. wheels, but without other change (both of these have superheaters); a mogul which is the original design with the exception of the Walschaert valve gear, superheater and radial stay boiler; two types of Mikado locomotives, one for freight and the other for passenger service and two types of Mallets in addition to the new eight wheel type mentioned above.

While this comprises the standard locomotives for the Associated Lines, it is not to be understood that experimental and development work has been throttled by their existence. There are in service several locomotives which are not standard and are intended for special work in certain districts. The most noticeable of these is the lignite burning Pacific types of the Oregon Railroad and Navigation Company and the balanced compound Atlantic types for the Union Pacific.



Standard Mikado Locomotive With Superheater for the Associated Lines.

During 1912 one hundred and fifty-six locomotives were built for the Associated Lines by the Baldwin Works, and forty by the American Locomotive Company, all of them being of the modified and present standard for each type. These consisted of 36 switching locomotives; 55 freight Mikados; 10 passenger Mikados; 55 Pacifics; 15 moguls; 10 ten-wheelers and 15 Mallets of the 2-8-8-2 type. The general dimensions of these locomotives, as well as the latest design of the 2-6-6-2 type, are given in the accompanying table which by the comparison with the dimensions as given on the original locomotives to be found in the *American Engineer,* as noted, will show what alterations of weights and proportions have followed the changes in the boiler and valve gear.



Mogul Locomotive With Superheater for the Associated Lines.

Possibly one of the most interesting of these locomotives is the

mogul type which is fitted with a superheater, outside steam pipes and Walschaert valve gear. These engines have a tractive effort of 33,300 lbs., 21 in. x 28 in. cylinders and 63 in. drivers. There has been no reduction in the steam pressure in connection with the application of the superheater. The 70 in. boiler has flues 12 ft. 8 in. in length and if the superheating surface is figured on each sq. ft. being equal to 1½ sq. ft. of evaporative heating surface, there is over 224 sq. ft. of equivalent heating surface to each cubic foot of cylinder volume. It is quite evident that this design of locomotive, equipped for oil burning, will be very efficient up to the limit of its drawbar pull.

The Mikado freight locomotives are coal burners and are evidently fully capable of undertaking heavy work at moderately high speeds. The boilers provide 358 sq. ft. of equivalent heating surface per cubic foot of cylinder volume, which is an unusually high ratio for a freight locomotive. They are fitted with brick arches and do not differ from the design already in service with the exception of the changes in the boiler.

In the Mallet locomotives the separable boiler with feed water heater has been retained but the smokebox reheater has been discarded and a high degree superheater has been applied. The header of the superheater is placed in the chamber between the boiler proper and the feed water heater, and the steam pipes pass out through the sides of this chamber and extend back along the boiler between the cylinders. They are fitted with expansion joints. These locomotives are arranged to run with cab ahead.

(Note.—For full description with illustrations of the different details of the common standard locomotives adopted in 1903 see *American Engineer and Railroad Journal*, 1905, pages 154-200-250-288-322-353-400-441. A photograph and brief description of the Pacific type will be found on page 104 of the 1906 volume, and of the Atlantic type on page 139 of the same volume. A balanced compound Atlantic type which is standard in all particulars with the exception of the cylinders, valve gear, axles, etc., is described on page 308 of the 1906 volume. Oil burning locomotives of the ten-wheel type for the Southern Pacific are described on page 408 of the 1907 volume. In the 1909 volume, on pages 181 and 367, is a full description of the 2-8-8-2 type Mallets designed in that year. A lignite burner of the Mikado type built for the Oregon Railroad and Navigation Company is illustrated and described on page 404 of the 1910 volume, and on page 256 of the 1911 volume will be found a description of the Pacific type for the same company, arranged for burning lignite. The 2-6-6-2 type passenger locomotive is described on page 406 of the 1911 volume.)

SLATER FRONT END

It has been found quite difficult with the present design of locomotive front ends to keep the netting and baffle plates sufficently tight to prevent live sparks from working their way through them to the stack and thence to the ground, endangering the surrounding country with fires. To prevent this, the Chicago & North Western some time ago tried out a new arrangement of front end which was originated by William Burdett, foreman boilermaker of the Northern Wisconsin division, and perfected and patented by F. Slater, master mechanic of the Peninsular division. This has proved entirely satisfactory. With this design the joints can be made tighter and are less affected by the heat and vibration, there being less complicated and difficult connections.

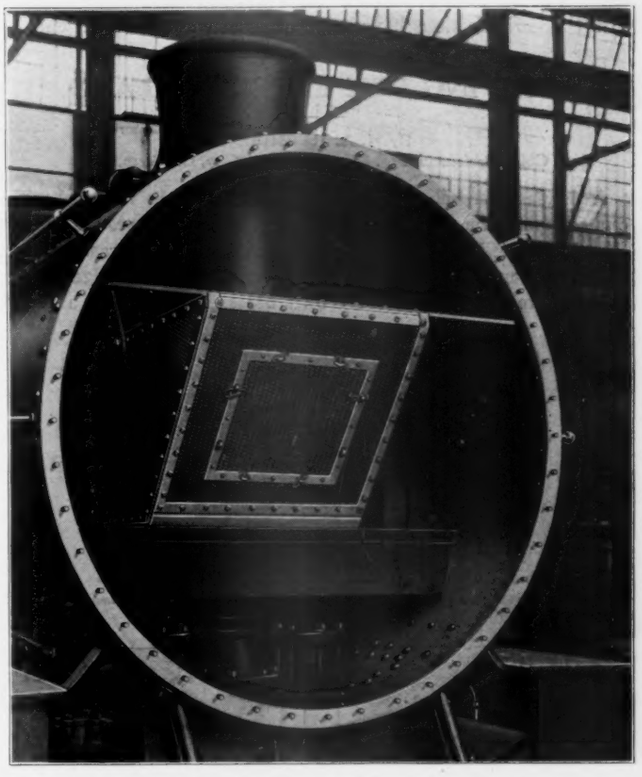
The engines running in the wooded territory have been gradually equipped with this device since January, 1911, with a remarkable decrease in the number of fire claims due to sparks from the locomotive. The amount paid for these claims was $129,250 for the fiscal year ending June 30, 1911, and $63,787 for the year ending June 30, 1912, or a decrease of about 50 per cent. While this decrease cannot be said to have been wholly due to the application of this device, the greater part of it is.

Before adopting it as the standard front end a test was made on a ten-wheel locomotive by H. T. Bentley, principal assistant superintendent of motive power and machinery, who was accompanied by Prof. J. G. D. Mack of the University of Wisconsin and E. M. Griffith, state forester of Wisconsin. It was found that over a distance of 58 miles from Green Bay, Wis., to Oshkosh the observers counted only 22 live sparks, all of which died out before striking the ground. During the test the engine was made to work as hard as possible so as to present the most unfavorable conditions.

In addition to the spark reducing feature, it has been found that engines equipped with this front end are freer steamers and that the coal consumption is materially reduced. While there have been no distinct tests regarding this point, the enginemen claim that in most cases they can cover their runs with from 5 to 10 per cent. less coal than before. This is due perhaps to the open and less restricted construction in the smokebox which allows a freer draft through all the boiler tubes and involves less liability of the flues becoming clogged.

It was found that a larger netting area could also be obtained with this front end which also will tend toward better draft. The accompanying table shows the difference, in sq. in. of netting area per flue, between the old and the new arrangement on some of the North Western engines:

Type of Engine.	Old.	New.
Class A—4-4-0	8.566	9.64
Class B—4-4-0	7.054	8.32



Slater Front End Which Has Proved Efficient as a Spark Arrester.

Class D—4-4-2	8.375	9.77
Class E—4-6-2	6.5	9.06
Class I-2—2-6-0	11.746	12.72
Class M-1—0-6-0	11.34	12.28
Class R-1—4-6-0	8.376	11.63
Class Z—2-8-0	6.685	9.43

The construction of this front end is simple and compact, and is as cheap to make and install, if not cheaper, than the ordinary type of front end arrangement. It is possible to inspect all its parts without having to remove various nettings, plates, etc., and any repairs are easily made. There are no difficult joints to be made around the steam pipes. Everything is straightforward work, all parts being made to a template.

The drawing shows the Slater front end applied to a consolidation locomotive (Class Z), and although the method of applying the device will vary with different types of engines, the arrangement is typical. There is a diaphragm *A* of 3/16 in. plate, extending across the smokebox under the steam pipe tee and down to the base of the netting box, which deflects the smoke and cinders down under the box and against the deflecting plate

B. With this arrangement of the diaphragm no holes are cut through it for the steam pipes. The sides and inclined front of the box are made of No. 14 perforated plate with the perforations running horizontally, the customary netting door being provided as shown in the photograph. A 3/16-in. table plate extends across the lower part of the smokebox on a level with the top of the exhaust nozzle. This is cut away in the center so that the nozzle may be removed; a small plate is bolted to the tip as indicated at *C*, giving an absolutely cinder-proof construction.

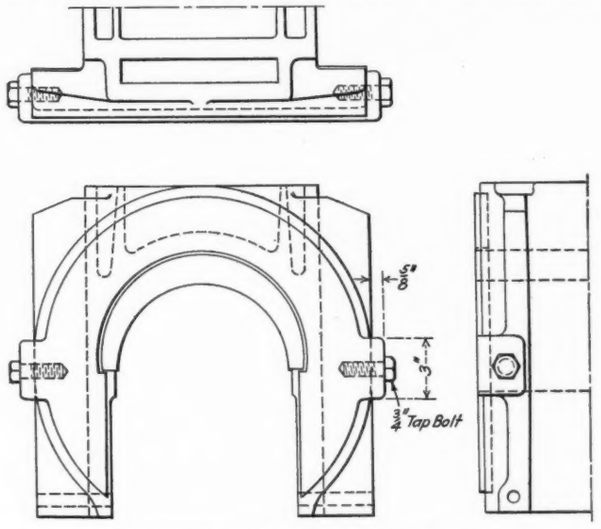
The blower connection is made in the exhaust tip at *D* just below the bottom plate so that it will not be necessary to run the pipe through the sides of the netting box. The petticoat pipe is fixed to the top and bottom table plates. The stack and the netting box are connected by a malleable iron collar made in halves and riveted to the angle on the top of the box. A clamp collar is placed outside of this collar and is tightened so as to cover the joints in the inside collar. This clamp collar also protects this connection from abrasion due to the action of the cinders; it is shown in position in the photograph. About 70 per cent. of the engines of the North Western and practically all of those running in the wooded sections have been equipped with this front end.

DRIVING BOX LATERAL PLATE

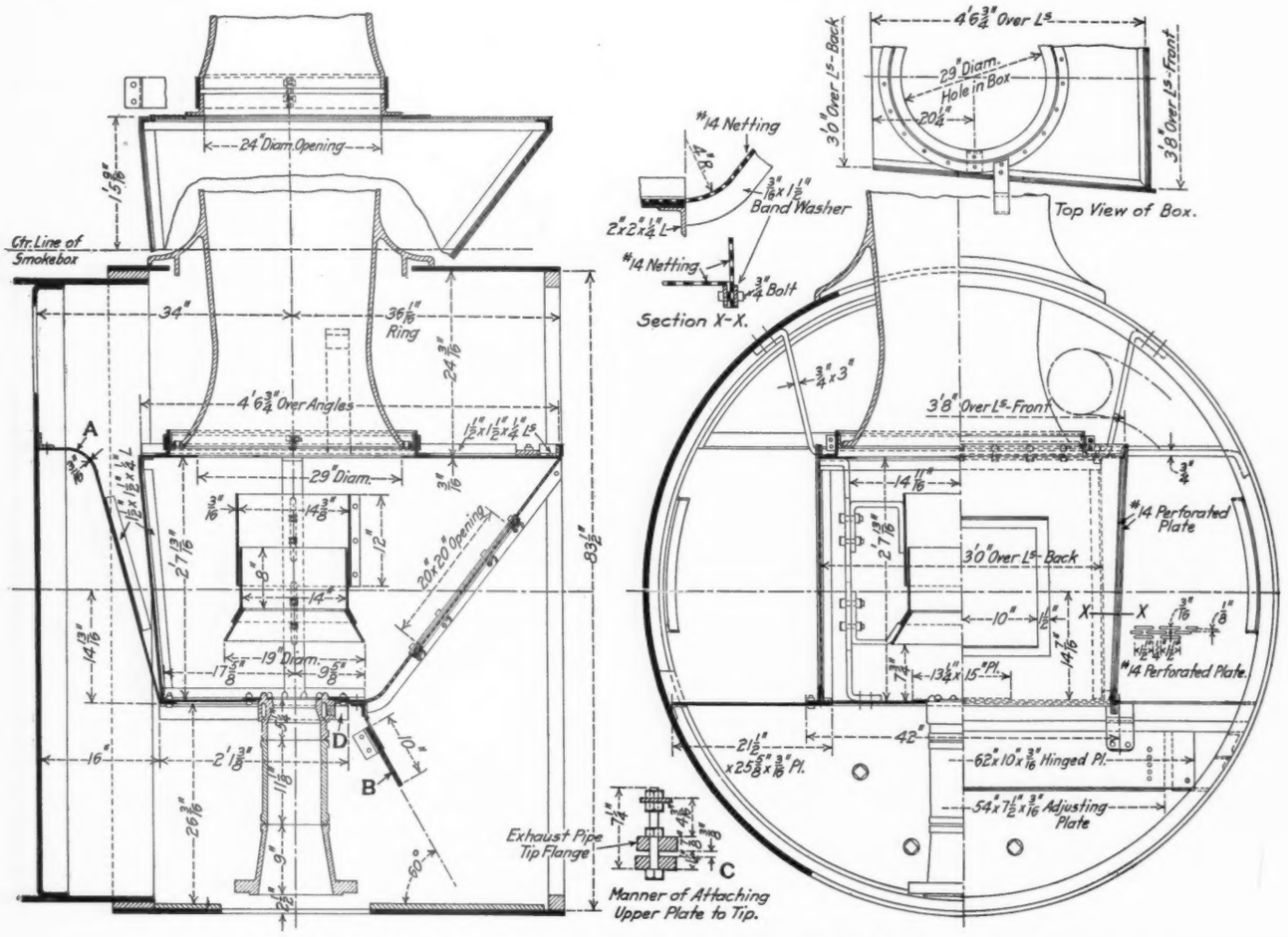
By H. A. HERNDON,
Chief Draftsman, Fort Worth & Denver City, Childress, Tex.

A driving box hub or lateral plate which can be renewed without dropping the wheels is being used with good results on the Fort Worth & Denver City. The plates are cast of brass and are made to standard sizes, having a rough fit in the edge of the counterbore and around the crown brass. They set in a recess in the box and are held in place by two tap bolts at the sides. Properly shaped lugs on the plate extend over the edge of the box for this purpose. Only the face and back of the plate and the inside of the lugs are machined.

All that is necessary to remove or apply a plate is to remove the tap bolts, drop the shoe and wedge, move the box inward on the axle and lift out the old plate and put in a new one. The idea originated with H. L. Kelly, shop foreman of the Fort Worth & Denver City at Childress, Tex.



Removable Driving Box Lateral Plate.



Slater Front End as Applied to a Chicago & North Western Consolidation Locomotive.

FACTORS IN THE SELECTION OF LOCOMOTIVES

Discussed From a Broad Engineering Standpoint by the American Society of Mechanical Engineers.

Two papers were presented at the Railway Session of the American Society of Mechanical Engineers, held in New York on December 5, 1912. The first on Train Lighting by Messrs. Currie and Wood was published, in abstract, in the December issue of the *American Engineer,* page 614. The second, by O. S. Beyer, Jr., was entitled, Factors in the Selection of Locomotives in Relation to Economies of Railway Operation. An abstract of the paper and a report of the discussion follows:

MR. BEYER'S PAPER.

The problem of locomotive design is comparatively simple when it is clearly known what is desired. The possibility of effecting operating results by the introduction of improved locomotives alone, or by their use in connection with such changes as grade revision, is not as fully appreciated as it ought to be. To make an intelligent selection of motive power for a railroad, it is necessary to study the effect which various types and sizes of locomotives will have on operating expenses and fixed charges. Statistics published by the Interstate Commerce Commission covering the entire railroad field of the United States show that 55 per cent. of the operating expenses are affected more or less directly by the motive power.

The wide range of motive power now available will have to be considered in future double track and relocation work, grade reduction, elimination of rise and fall, and curvature and distance, in order to effect the greatest economy possible for the capital expended. It should no longer be necessary when relocating a division to increase its capacity and reduce operating expenses, to go to extremely heavy capital expenditures to reduce grades to the minimum of 0.2 or 0.3 per cent., as it is usually much cheaper to provide locomotives of greater power.

The main steps in the careful selection of motive power may be divided into the consideration and study of: the service; the nature of the business; the topography of the road, train speed and train resistances; the types and sizes of locomotives available; the improvements to the permanent plant; the effect of various types and sizes of locomotives on operating expenses; and the final selection of most economical type and size of locomotive.

Passenger Engines.—Grades, speeds, and train resistances must be very thoroughly considered when new passenger engines are to be purchased. The most essential quality to be provided in a passenger engine is the ability to maintain large sustained tractive efforts at high speeds, as well as high starting efforts at low speeds. This ability of a passenger engine is secured by providing ample boiler capacity and good steam engine efficiency.

Freight Engines.—Freight and pusher engines are engaged in a service which requires at the critical time very high tractive efforts at slow speeds. This depends to a large extent upon the weight placed on the drivers and the total weight of such engines must thus be so distributed that a relatively large weight falls on the drivers. Modern conditions demand an increase in fast freight service and relatively large sustained tractive efforts at high speeds over heavy grades are becoming more necessary than ever. Locomotives for fast freight service only may afford to sacrifice some initial tractive effort for the sake of having recourse to a proportionately larger heating surface when great quantities of steam are necessary at high speeds. Pusher engines and road engines, on the other hand, intended exclusively for slow service may be permitted to have a large tractive effort capacity at slow speeds with a sacrifice in high sustained tractive efforts at high speeds.

Consideration of the topography of the railroad and the hauling capacity of freight locomotives presents the problem of permissible train lengths. If the territory over which the locomotives are to operate is, to a large extent, a succession of many sags and pitches and contains several momentum grades, the continual running in and out of the slack between the cars is a serious matter and tends to limit the length of the train and the amount of tonnage per train which can be hauled. The nature of the business, whether it is ore, coal or pig iron moving in high capacity modern steel cars, or general merchandise moving in box cars, refrigerators, small capacity gondolas or other similar cars has a further bearing on this feature. The lower the average total car weights of trains the longer the trains when large amounts of tonnage per train are hauled. Most of the extremely long trains are running over territories whose grades are low, or which have no broken profile. Furthermore the nature of the lading hauled in these exceedingly long heavy trains, is such that, should any heavy shocks occur, the lading cannot be damaged. Cars filled with automobiles, furniture, or general merchandise or flat cars loaded with agricultural machinery are different and must be handled with greater care in shorter trains. Every district for which motive power is intended presents certain little peculiarities when advisable train lengths are considered. Experience in the operation of trains hauled by the older types of locomotives must assist in determining the final answer to this question.

SIZES AND TYPES OF LOCOMOTIVES.

The Atlantic and Pacific type engines, under modern operating conditions, are, for high-speed and high-capacity passenger service, the most desirable types. Under certain special circumstances, long continuous opposing grades may justify compounding in connection with these engines. The introduction of the high temperature superheater and the sectional brick arch have helped materially to increase the capacity, fuel economy, and efficiency of passenger engines. The limitations of Atlantic and Pacific type passenger engines are principally controlled by the permissible wheel loads. When 60,000 to 63,000 lb. per pair of drivers is once reached, it is questionable, from many points of view, whether it is wise to go still higher. Hence, when greater tractive efforts are necessary than can be secured from an engine with 180,000 to 190,000 lb. on drivers it becomes a question of either reducing schedules, double heading, or introducing locomotives with an additional pair of drivers.

Recent developments have made available an exceptional field from which to select locomotives for freight service. It seems limited not so much by the extent to which it is possible to build freight engines as it is by the physical restrictions of the permanent way, the nature of the freight business hauled, length of trains, and topography of the road. These limitations are, of course, mostly very serious, and, as far as track gage is concerned, insurmountable, except perhaps in some special cases.

Many moguls (2-6-0), ten-wheel (4-6-0) and Prairie (2-6-2) type locomotives are in freight service today. Their capacities, especially the mogul and ten-wheel types, are hardly adequate for modern service conditions. The Prairie type, due to the possibility of equipping it with a liberal boiler and liberal grate area, has a few advantages over the others.

The type of locomotive which has been the standard on many of the American railroads in the past ten years is the consolidation type. It has been called on to perform in services ranging from emergency passenger to slow heavy pusher and switching service. Engines of this type are being built for heavy and exacting freight service and their possibilities have not been exhausted. They utilize nearly the total weight of the engine for adhesive purposes. A leading truck of two wheels only is

provided permitting of a slightly extended boiler and taking from the drivers only weight enough to secure good guiding qualities. The steaming capacity, firebox size and grate area are necessarily limited, since the entire boiler and firebox must be carried over the drivers. The handicap imposed by the boiler limitations has not, until recently, been very serious.

Engines of the consolidation type, having a maximum tractive power of 60,900 lb. are in service today. The diameter of their drivers is small, 54 in., and their total heating surface compared with the equivalent heating surface of a Mikado engine having the same tractive effort is but 70 per cent. The piston speeds of these large consolidation engines, compared with the Mikado engine, are considerably higher.

The perfection of the high temperature superheater, the brick arch, and the Gaines combustion chamber opens up further opportunities for the consolidation engine. The application of the superheater results in increased capacity which corresponds, roughly to a 25 per cent. larger boiler capacity than it was possible to provide in connection with saturated steam engines. The brick arches permit increased amounts of heat to be utilized from the fuel burned on restricted grate areas. It should be possible to build consolidation engines with good steaming capacities and economical fuel requirements that can develop as high as 54,000 lb. maximum tractive effort.

An offshoot from the successful consolidation freight engine is the 12-wheel or 4-8-0 type. This type has an undesirable ratio between total weight and adhesive weight. The increase in the length of boiler made possible by the four-wheel truck nets but little in the direction of increased boiler capacity. The increase in the heating surface of the boiler is at the wrong end. To improve the steaming capacity of the consolidation engine it is necessary to introduce modifications at the firebox end.

The introduction of such modifications has resulted in the Mikado (2-8-2) type. By placing a trailing truck underneath the firebox better boiler construction becomes possible; also a decided increase in effective heating surface, a deeper throat sheet and wider water legs are secured. However, as large a proportion of the total weight of the engine is not utilized for adhesive purposes as with the consolidation type. By moving the firebox behind the drivers, it also becomes possible to enlarge the boiler diameter, and to increase the relative diameter of drivers, thereby permitting of lower piston speeds. The general construction of the Mikado locomotive is such that it permits of very ample steaming capacity and thus of high sustained tractive efforts. The application of the superheater and brick arch has further increased its capacity in this direction. It is most admirably suited to haul slow maximum tonnage freight trains one day and fast freight trains the next, a condition frequently met in railroad operation.

The size of Mikado locomotives for most roads is principally limited by the allowable weights on drivers. It seems to be generally considered that an individual axle load of 60,000 lb. for the better conditions of roadbed, as they are met with today, is very nearly the largest permissible. If so the Mikado engine, as far as size is concerned, has very nearly reached its limit, and the demand for still larger engines will have to be met either by introducing another pair of drivers, making five pairs in all, or by resorting to the Mallet type.

To get still larger capacities than are provided by the consolidation and Mikado types, the decapod (2-10-0) and the Santa Fé (2-10-2) types are available. The decapod type, like the consolidation and 12-wheel types, has limitations as regards boiler capacity, in consequence of which it is practically adapted to slow service only. Its high proportion of weight on drivers, giving it a high ratio of adhesion is of advantage for this kind of service. The Santa Fé type permits of better boiler proportions than those of the decapod type, just as the Mikado is better than the consolidation. The additional pair of drivers enables a tractive effort about 20 to 25 per cent. greater than can be secured from the Mikado engine. Allowing 60,000 lb. per pair, the maximum tractive effort possible should be about 73,000 to 75,000 lb., barring cylinder limitations. Several engines of this type now in service deliver a maximum tractive effort of 71,000 lb. It is reported that they can be handled by one fireman without unduly taxing him.

Locomotives with five pairs of coupled wheels have an exceedingly long rigid wheel base. This would introduce many complications should they be placed on territories where track curvature is frequent or severe. Furthermore, the exceptionally heavy pressures on the main pins and the heavy reciprocating parts justify expectation of maintenance difficulties. The long wheel base and the large number of heavy wheel loads in rigid order may be proportionately harder on the track than is the case with large Mikado engines.

Another type of engine which deserves consideration for freight service is the Mountain (4-8-2) type, which is similar to the Mikado in all its characteristics. Where fast freight service is abundant and high speed is frequent the additional advantages in guiding qualities secured by the four-wheel leading truck and the slightly increased boiler capacity are important.

The Pacific type engine for exclusive fast freight service, where grades are not severe and where this kind of service is heavy, is a very desirable type. A large number of these engines have been built for this service and are giving an excellent account of themselves.

The Mallet type offers quite as wide a field to choose from as the non-articulated types. They can be built to deliver a maximum tractive effort of 140,000 lb. This means an engine with ten pairs of drivers, having an average load of about 60,000 lb.

THE PERMANENT PLANT.

The permanent plant of a railway as related to the motive power is the track, bridges, passing sidings, terminal yards, engine terminals, including the roundhouses, turntables, coaling stations, watering cranes, ash plant and sanding facilities, and the locomotive repair shops. It has been shown what a wide range of motive power is available from which selections may be made for any class of service. In order that the possibilities of this large field may be fully realized it becomes necessary to study carefully the various changes in the permanent plant to be considered in connection with the introduction of different types and sizes of engines. Such a study will oftentimes show that improvements made to the permanent plant at limited costs will permit of utilizing motive power which will effect a considerable saving in operating expenses, thereby fully justifying the expenditure.

OPERATING EXPENSES.

The effect of the selection of locomotives for passenger and switching service on operating expenses does not play as important a role as it does in the selection of engines for freight service. The choice of passenger and switch engines is determined very largely by imposed conditions resulting from circumstances peculiar to the nature of these two kinds of service.

In the selection of power for freight service the effect of the various types and sizes on the operating costs should go a long way towards determining the most economical engine to choose. A study should be made to determine which type and size will effect the greatest net saving in operating expenses after deducting all overhead and additional maintenance charges resulting from the improvements necessitated by the introduction of the engine. Only by such a study as this in conjunction with considering the service conditions and the tendency of future development can the ultimate selection be made with any degree of correctness.

Fuel is the largest single item of locomotive operating expenses and therefore the most important. As locomotives grow larger their fuel consumption per unit increases, but not nearly in proportion to the increase in their size. It does not take very much more coal to fire a large locomotive than a small one. The fuel

losses of a large locomotive due to radiation while waiting or drifting are but slightly larger than those of a smaller locomotive. The increase of fuel consumption of large saturated simple steam engines when working at their full capacity is more nearly in proportion to the increase in their size. The introduction of the superheater, feedwater heater and reheater, the increase in heating surface of the boiler, the brick arch, the utilization of compounding in large engines of the Mallet type, application of improved valve gear and compound air pumps, and more careful attention to the design of steam passages and steam engine efficiency have accomplished remarkable results in keeping the fuel consumption of large locomotives down so that their consumption per train-mile is increased but slightly over that of the recent types of smaller saturated steam locomotives.

Numerous tests and service records have revealed that large superheater Mikado locomotives which have been placed in service recently haul trains of 45 and 50 per cent. greater tonnage with the same amount of coal that was formerly consumed by the consolidation locomotives they replaced. Even the coal consumption of Mallet engines with grate areas up to 100 sq. ft. has not grown in any way proportionate to the increase in their hauling capacity. Modern engines when running at shortened cut-offs over those portions of the road other than the ruling grades exhibited a still greater economy than when working on the heaviest grades. Some service tests of recently built Mikado engines on the Delaware, Lackawanna and Western clearly demonstrated these facts. Their economy in fuel consumption as compared with that of the old consolidation type, both operating over heavy grades at full load, was 20 per cent. The economy effected over easy grades while running at shortened cut-offs was 39.3 per cent., almost twice as much. The average was 29.1 per cent.

[The following features were also briefly considered: Water; lubrication of locomotives; other supplies for locomotives; engine house expenses; train supplies and expenses; wages of enginemen; wages of trainmen; locomotive repairs; freight train car repairs; maintenance of track, bridges and buildings; and overhead charges.]

FINAL DETERMINATION OF THE MOST ECONOMICAL LOCOMOTIVE.

Taking each one of the items into consideration, estimating the reduction in train mileage effected by each type, the gross savings in operating expenses effected based on the amounts of business on hand or in sight, and deducting therefrom all overhead charges arising from the additional improvements necessary to make the operation of the different types of locomotive under comparison practical, will reveal which particular locomotive is the most economical in size and type.

As far as a standard engine of any kind for an entire road is concerned the general conditions obtaining will have some bearing. A road may, for instance, be composed partly of divisions whose grades are moderate and partly of divisions whose grades are severe. If the variations are not great a compromise standard might be adopted. If on the other hand there is a large difference, it may be wiser to seek to establish two or three standards and confine them to their particular territory with a view to getting the maximum efficiency from every portion of the property. Then again there are many shorter territories such as pusher grades and divisions through mountainous country, the motive power selection for which is a distinctly local problem. In every case, whether it is the broad problem of establishing standards for the entire system, or selecting an engine for a local territory, the problem might well be reduced to an economic study, comparing several available types and sizes, the extent of the improvements necessary to make their operation practical, and the net savings which it is estimated will be effected by their introduction.

SUMMARY.

In designing new locomotives all of the conditions must first be analyzed and then the design made to suit them. The actual design of the engine finally chosen may be approached with confidence because of accumulated knowledge and experience. Due to the great possibilities of favorably effecting operating results by building locomotives which are exactly suited to their work, a study of the conditions becomes vitally important. To show what these conditions are has been the object of this paper. The fact that the most powerful locomotives of most approved design are also the most economical should be more generally appreciated. It is to be hoped that the future will see more advantage taken of the modern locomotive in accordance with its possibilities in relation to grade revision and its ability to reduce operating expenses to a minimum. The ultimate benefits which will result will certainly be justified to the fullest extent.

DISCUSSION

COMMON STANDARD LOCOMOTIVES.

H. H. Vaughan, assistant to the vice-president of the Canadian Pacific, emphasized the importance of having standard locomotives and maintaining these standards until conditions change so much that it is possible to design another line of standard locomotives, making a distinct step in advance, rather than to modify the standard types from time to time. The time for standardization is before the equipment is built and not afterward. The Canadian Pacific now has about 865 standard locomotives out of a total of 1,800 or 1,900 on the system. It is always possible to introduce changes in the design of details on standard locomotives, bearing in mind that the new arrangement must be made so that it can completely take the place of the old part for renewals or repairs.

The advantage of standardizing the motive power may be summed up as follows: The standard locomotives can be transferred from one part of the road to another, when business becomes heavy on one section, without having to provide a new storehouse stock, or have the power crippled because of not having the proper parts in stock. It is also possible to keep the shop cost of the engines down because of fewer variations in the size and design of the parts. Where standard locomotives are used it has been found that the division officers are much more likely to offer suggestions as to improvements. Of course, the standardization has disadvantages, one of which is that it is not always possible to immediately take advantage of improvements in the permanent plant. The advantages of having common standards which can be used on any part of the system and with which the men over the entire system are familiar, greatly offset this, however.

POSSIBILITIES OF ATLANTIC TYPE.

In speaking on the possibilities of the Atlantic type W. F. Kiesel, Jr., assistant mechanical engineer of the Pennsylvania Railroad, said:

"To determine the possibilities, the limitations must first be known. The limitations of paramount importance with a locomotive are those governed by the carrying capacity of the track and roadbed. Assuming a good roadbed, having 22 in. spacing of ties and 100-lb. rail, it will be possible to use a weight of 70,000 lbs. per pair of drivers. The maintenance of way department will be inclined to say that this figure is too high, but there are possibilities of reducing the weights of reciprocating parts by the judicious use of alloy metals and by careful design, resulting in reduction of counterbalance, which in turn reduces the strain on the rail. One pound reciprocating weight per 100 lbs. of maximum piston pressure is within the bounds of possibility. For an Atlantic type locomotive this would permit using counterbalance for reciprocating parts of one-third their weight. At very high speed there would be no more strain on the rail than that induced by heavy locomotives now in service. The load on front and trailer trucks may be taken at 110,000 lbs. The total weight of this imaginary Atlantic type locomotive would then be 250,000 lbs.

"There are few possibilities of improvements in the engine it-

self. The utilization of heat-treated steel and cast-steel cylinders will reduce weight, which reduction can be used for increase in boiler. The development of the possibilities of the boiler will bring about improvements of greatest import. The superheater and brick arch have already raised the line between non-stoker and stoker locomotives 50 per cent., leaving all Atlantic type locomotives well within the non-stoker class. The indications are that great steaming capacity can best be obtained with flues of moderate length, and that the generally accepted theory that long flues increase boiler efficiency is not altogether correct.

"Before further developing this imaginary locomotive permit me to present some average figures obtained from an Atlantic type locomotive, on the Pennsylvania Railroad locomotive test plant, at Altoona, Pa., as a basis for possible boiler performance. The general characteristics of the locomotive tested are as follows:

Weight	237,000 lbs.
Boiler pressure	205 lbs.
Cylinders	22 in. x 26 in.
Drivers	80 in.
Fire heating surface	3,090 sq. ft.
Grate surface	55 sq. ft.
Flue diameter	Outside, 2 in.; inside, 1¾ in.
Flue length	13 ft. 9 in.

"The boiler was equipped with a long brick arch, a combustion chamber, and a superheater. Forty tests were made, eight of two hours each, nine of one and one-half hours each, seventeen of one hour each, five of one-half hour each, and one of fifteen minutes. The maximum speed was 360 revolutions per minute. In each test the speed, cut-off, pressure, and power developed were maintained as uniform as possible. In the various tests the average indicated horse power developed ranged from 756 to 2,355. Nineteen tests, with average indicated horse power ranging from 756 to 1,700, averaged 2.35 lbs. of dry fuel per indicated horse power. Thirteen tests with average indicated horse power ranging from 1,700 to 2,000, averaged 2.71 lbs. of dry fuel per indicated horse power. Eight tests, with average indicated horse power ranging from 2,000 to 2,355, averaged 3.08 lbs. of dry fuel per indicated horse power. For this last lot of eight tests the average steam per indicated horse power was 17.03 lbs., and the minimum was 16 lbs. The maximum evaporation was 38,846 lbs. per hour, or 12.6 lbs. per square foot of fire heating surface per hour, equivalent to 52,084 lbs. per hour, or 16.9 lbs. per square foot of fire heating surface per hour from and at 212 deg. Fahr. These tests indicate the possibility of one indicated horse power per 100 lbs. weight of locomotive, or for one and one-third square feet of fire heating surface, at 80 miles per hour.

"Returning now to the imaginary locomotive weighing 250,000 lbs.; the weight on drivers, 140,000 lbs., limits the drawbar pull in starting to about 31,000 lbs. The boiler can be made sufficiently larger than that of the locomotive tested to furnish steam for 2,500 indicated horse power maximum, available for short periods in emergency. For trains of the present day more than 1,800 indicated horse power would seldom be required. At 16⅔ lbs. of steam and 2.5 lbs. of dry coal per indicated horse power, this would require 30,000 lbs. of water and 4,000 lbs. of coal per hour.

"What can be expected from such a locomotive? This question can best be answered by determining how much power is required in fair weather to pull ten cars, weighing 600 tons, assuming that the engine and tender together weigh 200 tons. The starting power is just sufficient to start this train of 800 tons on a 1 per cent. grade. The indicated horse power necessary to maintain a given speed under various grade conditions is given in table below:

40 miles per hour on 0.75 per cent. grade	2,030 indicated horsepower.
40 miles per hour on 0.5 per cent. grade	1,600 indicated horsepower.
50 miles per hour on 0.5 per cent. grade	2,175 indicated horsepower.
50 miles per hour on 0.2 per cent. grade	1,535 indicated horsepower.
60 miles per hour on 0.2 per cent. grade	2,085 indicated horsepower.
60 miles per hour on level tangent	1,575 indicated horsepower.
70 miles per hour on level tangent	2,160 indicated horsepower.

"From what has been determined above, based on facts, it would seem that 'the possibilities of the Atlantic type locomotive' are equal to the requirements of present day passenger service, for the locomotive weighing 250,000 lbs., if given 3,300 square feet of *effective* fire heating surface, would be capable of developing a maximum of

2,160 indicated horsepower at 40 miles per hour.
2,280 indicated horsepower at 50 miles per hour.
2,377 indicated horsepower at 60 miles per hour.
2,452 indicated horsepower at 70 miles per hour.
2,510 indicated horsepower at 80 miles per hour."

DYNAMIC WHEEL LOADS.

A. W. Gibbs, chief mechanical engineer of the Pennsylvania Railroad, brought out the fact that too much stress is laid upon the static wheel load and too little on the dynamic load due to the unbalanced weights. The real problem is to reduce the total effect of the static plus the dynamic, and this calls for greater attention to the design of the reciprocating parts. C. D. Young, engineer of tests of the Pennsylvania, who followed Mr. Gibbs, said that the Pennsylvania Railroad had under consideration a design in which it was expected that a material saving would be made in the weight of the reciprocating parts by the use of alloy steel.

BOILER DESIGN.

F. F. Gaines, superintendent of motive power of the Central of Georgia, said in part:

"There are many items to be considered in the proper selection of motive power. I will only call attention, however, to the question of fuel economy and boiler capacity—in other words, boiler design. There have been few radical modifications in boiler design other than the general introduction of superheated steam, except in a few isolated instances. The results obtained by Dr. Goss in the Coatesville tests indicate that there should be greater firebox and heating surface, and that the ratio of firebox heating surface to tube heating surface should be materially increased. With from 40 per cent. to 48 per cent. of the evaporation from the firebox sheets, it would seem logical to increase firebox heating surface and decrease tube heating surface. The results of the Coatesville tests, while a surprise to many, were anticipated by a few. The Philadelphia & Reading has a large number of its engines in which the ratio between firebox and tube heating surface is relatively high (one to six), and with tubes from about nine feet in length on American type passenger power to only 13 feet 6 inches on the heaviest types of consolidation locomotives. These results were obtained by the use of the Wooten type boiler with large grate area for anthracite coal, and a vertical brick wall at rear of the combustion chamber. The brick wall retards the flow of gases and also gives a better opportunity for combustion, as well as changing the path of the gases and forcing them against the crown sheet. The combustion chamber furnishes additional firebox heating surface and more volume in which to complete combustion. These engines, while designed for anthracite coal, occasionally got into soft coal territory and had to use it. The grate area was too large for maximum economy, but the results were excellent, notwithstanding.

"Impressed with the above experience, a trial was made of arranging a boiler having a suitable grate area for soft coal, with a combustion chamber. The back end and one waist course were removed from the original boiler and replaced by a new back end. Carefully conducted tests showed a coal economy of 40 per cent. over a sister engine and 15 per cent. over the best design of engine of similar power, but with more liberal heating surface. In addition to the fuel economy obtained, the shielding of the tubes by the firebox wall has resulted in the engine making over four times the mileage of other engines in the same district before safe ending the flues. During this period the engine has seldom, if ever, been reported to have flues blown, while with certain fuel conditions engines in the same territory have required blowing every round trip.

"The most radical improvement that can be made in the locomotive, and one that will be rapidly developed, is the use of greater firebox volume and heating surface. This is readily ob-

tained by using a suitable grate area and combustion chamber. In fact, from past experience it would not be surprising if ultimately a flue length of 16 ft. would become a desirable maximum, and the combustion chamber be substituted for the remaining distance."

In commenting on Mr. Gaines' suggestion, C. D. Young said that a study of the relation of the length and diameter of the tubes was probably of equal importance with the relative increase in firebox volume and heating surface.

FEED WATER HEATERS.

G. R. Henderson, consulting engineer of the Baldwin Locomotive Works, in commenting on feed water heaters, said: "Recently an extension of the boiler has been converted into a multitubular feed water heater and water from the injector is passed through this section before reaching the boiler proper. As some modern types of locomotives give ample space for a very long boiler, there is no difficulty in providing such a section using the heat after it passes through the boiler tubes proper. Experience with this type of feed water heater has been somewhat peculiar; in some cases very good results were obtained both in economy and in condition of the heater; but in other cases more or less corrosion has been found in the various portions of the heater, whereas there was no evidence of such corrosion in the boiler proper; these conditions have been more aggravated when good water was used than when water carrying scale and encrusting matter was supplied to the boiler. In an attempt to overcome this corrosion, in some cases the heater has been practically coupled to the steam space with circulating pipes both to the top and bottom so that it is really an extension of the boiler and will run only partially full of water instead of entirely full, as when originally designed as a heater. The strangest part of this problem is that we find when such connections are made the apparatus does not seem to lose its economical value as a heater. There is apparently no increase in fuel required when these circulating pipes are connected with the boiler.

"Some builders place a diaphragm sheet a few feet back of the flue sheet and extended as high as the flues, injecting the feed water into this front section and letting it flow backward over the diaphragm as necessary. While we do not know of any comparative tests made to determine exactly the fuel economy of this device, it seems as if this arrangement of connecting the heater directly with the boiler, so that it practically forms a part of it, is likely to be more satisfactory in the long run than when it is used as an individual heater for heating the water in its passage to the boiler without allowing any opportunity for the gases contained in the water to escape, as can be done with the circulating pipes."

SUPERHEATERS.

S. Hoffman, vice-president of the Locomotive Superheater Company, said in part: "Superheaters are being applied to practically all engines now building and the question when selecting new power is not whether a superheater shall be specified or not, but what can reasonably be expected from the application of the superheater to the particular engine in its particular service and what consideration should be given to the design of the superheater and to the general locomotive design in order to obtain a locomotive of maximum efficiency. The principal advantage to be derived from the application of an efficient superheater is a decrease in steam and fuel consumption and indirectly an increase in the steaming capacity of the boiler, which is equal to a proportional increase in the hauling capacity of the locomotive. In speaking of superheaters as applied to locomotives, I refer only to such devices as are capable of developing and maintaining a high degree of superheat averaging from 200 to 250 deg. above the saturation point.

"The principle which has been generally adopted in the design of locomotive superheaters is that of a superheater consisting of coils or units disposed in large boiler flues, with the forward ends of the superheater units suitably connected with a steam collector casting in the smokebox. The superheater unit pipes go within 2 ft. of the firebox tube sheets and are exposed at their extreme ends to temperatures of from 1,400 to 1,600 deg. Steam of such high degrees of superheat can be exposed to the cooling action of the steam chest and cylinder walls without condensation and at the same time has about 30 per cent. greater specific volume than saturated steam of the same pressure. A large part of this increased specific volume is again lost before the expansion of the steam in the cylinders takes place on account of the cooling action of the steam chest and cylinder walls. While the superheat of the steam leaving the superheater may be 200 to 250 deg., the average superheat of the steam in the cylinder at the moment the cut-off takes place is hardly more than 100 deg.; but the entire elimination of all losses through condensation, together with the remaining increased volume of the steam, effects under average conditions a saving of 30 per cent. and more in the steam consumption per indicated horse power, which gain corresponds to a saving in fuel consumption of from 20 to 25 per cent., compared with a saturated steam locomotive working under the same conditions.

"The real value of a locomotive from the motive power point of view must be ultimately measured by the tractive effort which it is able to exert on the drawbar at a certain speed. In order to bring out what bearing the above mentioned saving in steam and fuel consumption has on the hauling capacity of the locomotive, the following example is given: Assuming two locomotives of the same general dimensions, one being equipped with a high degree superheater. Under average working conditions, the superheater locomotive will show an economy in coal consumption of about 20 per cent., if the same indicated horse power is developed by both engines. If the superheater engine is now forced so as to burn the same amount of coal as the saturated steam engine, and assuming that this increased amount of coal can be burnt as efficiently in the superheater boiler as in the saturated steam boiler and that the increased volume of steam can be expanded in the cylinders as efficiently as in the saturated steam engine, then the indicated horse power developed would be $100 \div 80$ I. H. P. or 25 per cent. more than in the saturated engine. At the ordinary speeds of saturated steam passenger locomotives about 70 per cent. of the cylinder power is available at the drawbar, 30 per cent. being absorbed in moving the weight of the locomotive and in machine friction. As the power consumption for this purpose will not change materially in the two cases, an increase of 25 per cent. in indicated horse power represents an increase in haulage capacity of $25 \times 100 \div 70 =$ approximately 36 per cent.

"The above two assumptions bring us to two principal requirements for the maximum efficiency of superheater locomotives. The thermal efficiency of the boiler must not be reduced by the application of the superheater. With the type of superheater now generally adopted, no changes are made in the firebox, but the tube heating surface is altered by transferring part of it to the superheater. The superheating surface is not quite as efficient in heat transmission as the evaporating surface on account of the poor conductivity of superheated steam. In order to make up for this the steam must be forced to pass through the superheater pipes at high velocity even at the risk of wire drawing, and the superheating surface must be so disposed in the gas current as to offer each cubic inch of gases passing through the superheater more heating surface than the gases find in their passage through the ordinary boiler tubes which are in contact with water. Further, the total gas area through all boiler tubes must not be materially reduced by the application of the superheater and the boiler tubes and flues must be so proportioned and arranged that the stream of combustion gases emerging from the firebox is so subdivided that the necessary amount of gases is diverted through the superheater, in order to furnish the required degree of superheat. These requirements regarding the

subdivision of heating surfaces and gas areas have to my knowledge first been recognized by Dr. Wilhelm Schmidt, of Cassel, Germany, who is also prominently responsible for the introduction of highly superheated steam in stationary and marine practice.

"It is not always possible for the designer to meet exactly these requirements, but from a great many cases it can be said that under average conditions the total gas area through all boiler tubes is not reduced more than about 5 per cent. and the combined total heating surface based on the fire side of the tubes is increased by the same percentage through the application of the superheater. This makes a somewhat sharper draft necessary for the development of the maximum power. The exhaust nozzle of the superheater locomotive has at any rate to be smaller than in the saturated steam locomotive on account of the smaller volume of exhaust steam available. These considerations indicate that the superheater boiler uses the gases of combustion just as efficiently as the saturated steam boiler and therefore as far as the boiler efficiency is concerned it would be possible to make practical use of the above mentioned theoretical increase in hauling capacity.

"The second requirement assumes that the increased volume of steam be expanded as efficiently, or in other words, that the same cut-offs be used as in the saturated steam engine. This would mean a corresponding increase in cylinder dimensions which in many cases is not possible on account of limitations in adhesive weight, strength of running gear and other limitations. There will always be an increase in hauling capacity obtainable, but whether the theoretical maximum can be obtained depends on the size of cylinders, and depends also on the quality of the saturated steam engines with which the superheater engine is compared, or to which the superheater has been applied, whether the engine is correctly proportioned or over cylindered, or deficient in boiler capacity, etc. It depends also on the service in which the locomotives are used; whether the service is such as to be favorable to developments of higher degrees of superheat and more or less unfavorable to the saturated steam locomotive. In switching service superheater engines make a very favorable showing, although only a moderate degree of superheat is being developed, but the improvement in efficiency is so remarkable because the saturated switch engine is the most inefficient of all locomotives. Under all these varying service conditions the increased hauling capacity of superheater locomotives obtained in practical service varies between 20 and 30 per cent., and frequently even more.

"Obviously, any appliance which improves the combustion and raises the firebox temperature will tend to raise the degree of superheat and thus help to increase the efficiency of the superheater. The only efficient device in this respect is a long brick arch, and for this reason the application of brick arches in superheater locomotives is highly recommended. All these considerations indicate that the increased hauling capacity of the superheater locomotive is principally caused by the increased steaming capacity of the boiler.

"The opinion has been frequently advanced that the mean effective pressure in the cylinders is increased by the use of highly superheated steam and that this is the source of the increased hauling capacity of the superheater locomotive. This is not the case. If the superheater engine has the same general dimensions, the same cylinders and boiler pressure, and is worked at the same cut-off and at the same speed as the saturated steam locomotive, it will not produce an indicator diagram showing a higher mean effective pressure than the saturated steam engine. In many cases the mean effective pressure of the superheater locomotive will even be somewhat lower than in the saturated steam locomotive, on account of the expansion line of superheated steam dropping faster than the expansion line of saturated steam. If, therefore, the superheater engine and the saturated steam engine are working under identical conditions and have identical dimensions, the superheater engine cannot develop more drawbar pull than the saturated steam engine. If a large tractive effort at a certain speed is required, either the cylinders of the superheater engine must be increased or the engine has to be worked at later cut-offs, which again is made possible by the increased steaming capacity of the boiler. It is also evident that without changing the size of the cylinders or the boiler pressure, the superheater engine cannot start a heavier train load than the saturated steam engine.

"On saturated steam engines in many cases the size of cylinders is limited on account of fear of condensation. The superheater engine is not subject to such limitations and, therefore, allows in many cases a better use of the available adhesive weight. In order to increase the starting power, under average conditions, it will be advisable to increase the diameter of the cylinders of superheater engines 10 per cent. above the size of the cylinders of the saturated engine. This will not only correspondingly increase the starting power, but at the same time will make possible the use of the increased steaming capacity of the boiler, without unduly increasing the cut-off of the engine, and in many cases will allow the superheater engine to work with lower boiler pressures.

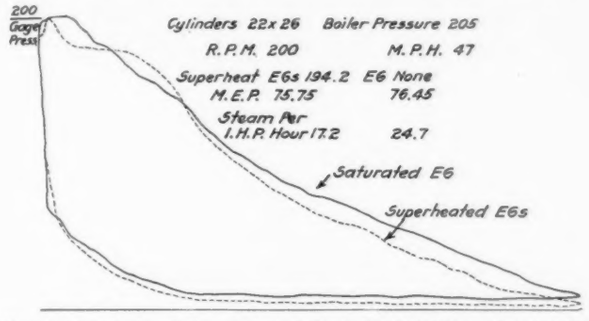
"Mr. Beyer has shown that locomotives of large capacity are more economical in operation than smaller units. He particularly cited the case of large superheater Mikado type locomotives which haul trains of 45 and 50 per cent. greater tonnage with the same amount of coal that was consumed by the consolidation locomotives they replaced. In order to develop the specified tractive effort these Mikado locomotives had to be equipped with cylinders of 27 in. diameter. What would have become of these poor engines with these big cylinders without the superheater! The cylinder condensation would have been so large as to make the operation of the engines a practical impossibility. There are no other means existing to entirely prevent cylinder condensation but superheaters, and superheating has made the most powerful locomotives with big cylinders possible.

"On Mallet engines built during the last two years superheaters have been quite generally applied, as the large surface to which the steam is exposed in the four cylinders and long steam pipes makes the application of this device even more necessary than in ordinary simple engines in order to prevent the increased amount of condensation. In most cases the superheater has been applied in front of the high pressure cylinder and the steam has been superheated sufficiently high to leave at least 30 or 50 deg. of superheat in the receiver steam. This remaining superheat makes it possible to use slide valves on the low pressure side; high pressure cylinders using steam of a high degree superheat cannot successfully be worked with slide valves.

"Repeated tests have been carried on particularly with a view of applying superheaters to old engines with slide valves, and in all cases which have come to my knowledge it has been found that slide valves cannot be worked successfully with highly superheated steam. Various means have been developed in order to improve the lubrication of the slide valves, but so far all have failed, because highly superheated steam has a tendency to warp the flat valve, which is the principal cause for the rapid wear of its bearing surfaces.

"Regarding the lubrication of piston valve superheater engines, great fear has been expressed as to the difficulties to be expected in this respect, but a great number of superheater locomotives now in satisfactory service, and causing no more wear on piston and piston valve rings and bushings than saturated steam locomotives, indicate that this question can be successfully solved. Two points, however, should be borne in mind in this connection, i. e., that superheater locomotives, working with highly superheated steam, should be lubricated with a cylinder oil having a higher flash point than the ordinary cylinder oil used in saturated steam locomotives, but without losing its lubricating qualities, and further means should be provided to protect the oil against carbonization while the engine is drifting. This protec-

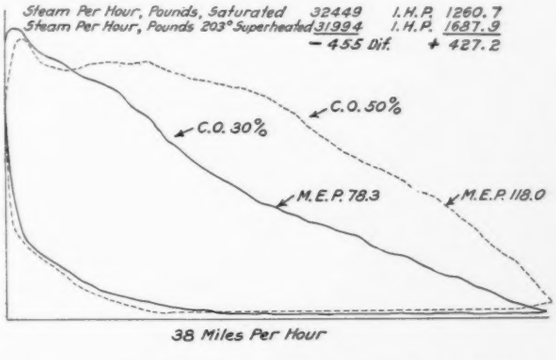
tion can be obtained by the admission of small quantities of steam to the steam chest and cylinders, while the engine is drifting after the throttle is closed. This auxiliary steam can be supplied either by cracking the throttle or by providing an auxiliary steam pipe to the cylinders. The latter can be worked

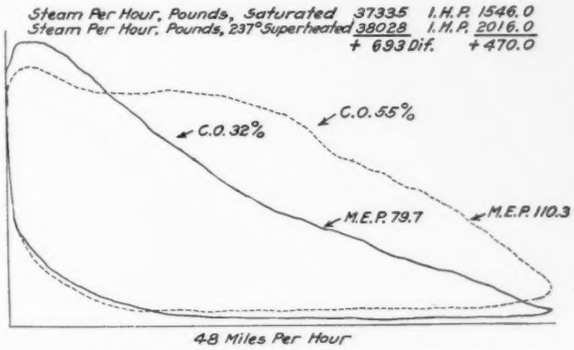


Indicator Cards for Saturated and Superheated Steam Locomotives Working Under the Same Condition as to Cut-off, etc.

by an auxiliary valve in the cab actuated either by hand or automatically.

"In addition to these means of improving the lubrication, it is essential to design all parts working under highly superheated steam so as to cause the least amount of friction and wear. This is being done by using the best quality of close grained iron for bushings and rings and by balancing the rings against inside steam pressures and by the application of piston valve rod guides,


Steam Per Hour, Pounds, Saturated 32449 I.H.P. 1260.7
Steam Per Hour, Pounds 203° Superheated 31994 I.H.P. 1687.9
− 455 Dif. + 427.2
C.O. 50%
C.O. 30%
M.E.P. 78.3
M.E.P. 118.0
38 Miles Per Hour


Steam Per Hour, Pounds, Saturated 37335 I.H.P. 1546.0
Steam Per Hour, Pounds, 237° Superheated 38028 I.H.P. 2016.0
+ 693 Dif. + 470.0
C.O. 55%
C.O. 32%
M.E.P. 79.7
M.E.P. 110.3
48 Miles Per Hour

Indicator Cards for Saturated and Superheated Steam Locomotives for Equal Weights of Steam Per Hour.

and piston rod guides at the front end, in order to reduce the weight pressing the rings against the bushings."

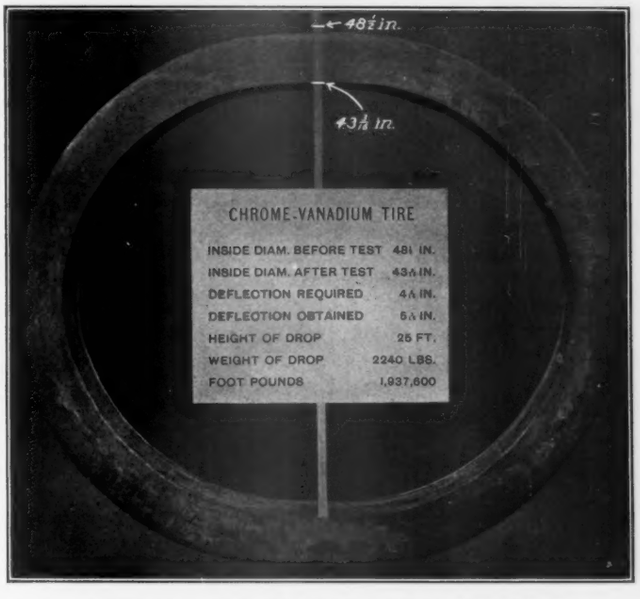
ADVANTAGES OF SUPERHEAT AS SHOWN BY INDICATOR CARDS.

C. D. Young, engineer of tests of the Pennsylvania Railroad, presented indicator diagrams for both saturated and superheated steam locomotives, which clearly show the advantages of the latter. It is believed that this is the first time that a comparison of this sort has been made. One set of indicator diagrams was for an Atlantic type locomotive with 22 in. x 26 in. cylinders, 205 lbs. of steam, and operating at 47 miles an hour with 200 deg. of superheat. This was compared with the diagram of a saturated steam engine with practically the same cut-off and under the same conditions. As may be seen from the diagrams, the card for the superheater engine showed a steam consumption of 17.2 lbs. per indicated horse power per hour, as compared to 24.7 lbs. for the saturated steam engine.

The other illustrations show saturated and superheated steam indicator cards for equal weights of steam per hour when operating under the same condition. In both cases the greater indicated horse power for the superheater engine is most noticeable.

CHROME VANADIUM DRIVING WHEEL TIRES

Tires made of heat treated chrome-vanadium steel were applied to a Pacific type locomotive weighing 229,500 lbs. total, and 150,500 lbs. on drivers, which was put in service on a division having numerous curves ranging from 3 to 14 deg. The average number of brake applications per trip was nine for station stops and four for crossings and slowdowns. Although flange lubricators were used on the other locomotives on this division none were applied to this locomotive. These tires, after an engine mileage of 121,000 miles, were found to still have good contours, but because of necessary repairs to other parts the locomotive was shopped. A sister engine in identical service had a new set of carbon steel tires applied one month after the vanadium tires were put on and these tires gave a mileage of only 60,040



Chrome-Vanadium Driving Tire After a Drop Test.

miles before having to be turned. It was necessary to reduce the diameter by ¾ in. in order to build up the worn flange.

In switching service, chrome-vanadium tires have given fourteen months' service, double turn, with a maximum wear of only ¼ in. It is reported that these tires, which are now on their third term of service between turnings, will probably be good for a fourth term.

Other railways in considerable numbers are now ordering tires of this material, and a specification has been prepared after exhaustive experiment and research by the tire makers and the American Vanadium Company. In developing this specification the effort was to determine the particular chemical composition of chrome-vanadium steel and the proper heat treatment which would give the highest wearing qualities. The success of the

specifications, which are given in full at the end of this article, is illustrated by some tests recently made on tires manufactured under them. Three tires, one each manufactured by the Midvale Steel Company, the Standard Steel Company and the Latrobe Works of the Railway Steel-Spring Company, were subjected to physical and chemical tests with the results given in Table 1. For comparison the properties of carbon steel tires are given in the last column.

Table No. 1.—Comparative Physical Properties and Chemical Composition of Heat Treated Chrome-Vanadium and Standard Carbon Steel Tires.

	Physical Properties.				
	Heat Treated Chrome-Vanadium Tires.				
	Obtained.			Specified.	Regular Carbon Tire.
Manufacturer	Standard	Midvale	Latrobe		
Elastic limit, lbs. per sq. in.	119,500	110,000	118,700	110,000 to 125,000	65,000
Tensile strength, lbs. per sq. in.	146,500	136,000	149,520	140,000 to 160,000	125,000
Elongation in 2 in., per cent.	15.5	17.0	15.0	Minimum, 12	12
Reduction of area, per cent.	39.0	48.6	34.4	Minimum, 30	17
	Chemical Composition				
Carbon, per cent.	0.55	0.57	0.62	0.50 to 0.65	0.68
Manganese, per cent.	0.64	0.694	0.62	0.60 to 0.80	0.70
Chromium, per cent.	0.88	0.95	0.95	0.80 to 1.10	0.00
Vanadium, per cent.	0.17	0.20	0.24	Over 0.16	0.00
Silicon, per cent.	0.30	0.289	0.27	0.20 to 0.35	0.250
Phosphorus, per cent.	0.034	0.037	0.015	Not over 0.05	Under 0.05
Sulphur, per cent.	0.04	0.023	0.028	Not over 0.05	Under 0.05

The strength and toughness of heat treated chrome-vanadium steel is clearly shown by the drop tests of each of these tires. A summary of the results secured is given in Table 2. The accompanying illustration shows the tire manufactured by the Standard Steel Works Company after being subjected to the drop test. The tire was 48½ in. internal diameter, 3⅝ in. thick. A deflection of 4 3-16 in. was required by the specifications, and a total of 5 5-16 in. was obtained after a total of 37 blows from different heights up to 25 ft.

In the drop test of the Midvale Steel Company, the tire was 55⅝ in. internal diameter and 3⅞ in. thick. All blows were from a height of 40 ft., seven blows in all were given. A total deflection of 5 7-16 in. was obtained, 4⅜ in. deflection being required by the specifications. The tire manufactured by the Latrobe Works of the Railway Steel-Spring Company was 56 in. internal diameter and 4 in. thick. Under the specifications a deflection of 3 11-16 in. was required. The total deflection obtained was 5 in., after a total of 22 blows from successive heights up to 30 ft., the limit of the drop.

Table No. 2.—Summary of Results of Drop Tests of Heat Treated Chrome-Vanadium Tires.

Maker	Standard	Midvale	Latrobe
Thickness	3⅝ in.	3⅞ in.	4 in.
Inside diameter before test	48½ in.	55⅝ in.	56 in.
Inside diameter after test	43 5/16 in.	50 5/16 in.	51 in.
Deflection required	4 3/16 in.	4⅜ in.	3 11/16 in.
Deflection obtained without breaks or cracks	5 5/16 in.	5 7/16 in.	5 in.
Maximum drop	25 ft.	*40 ft.	30 ft.
Weight of drop	2,240 lbs.	2,240 lbs.	2,240 lbs.

*Entire test made at this height.

Specifications for Heat Treated Chrome-Vanadium Steel Tires.

1. Steel for tires shall be made by the acid open hearth process. Sufficient discard shall be made to insure removal of piping and segregation.

2. *Chemical Composition:*

Carbon	0.50 to 0.65 per cent.
Manganese	0.60 to 0.80 per cent.
Chromium	0.80 to 1.10 per cent.
Silicon	0.20 to 0.35 per cent.
Vanadium	Over 0.16 per cent.
Phosphorus	Not over 0.05 per cent.
Sulphur	Not over 0.05 per cent.

The higher range in carbon to be used for switch and freight engine tires, and tender and car wheel tires; the lower range in carbon to be used for passenger engine tires.

The above limits are rejection limits for samples taken at any stage of manufacture.

3. Drillings from a small test ingot cast with the heat or turnings from a tensile specimen or turnings from a tire (where tires are machined at the works of the manufacturer) shall be used to determine whether the chemical composition of the heat is within the limits specified in Paragraph 2.

4. *Physical Requirements:*

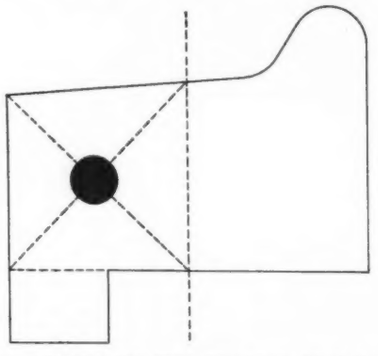
Tires Over 56 In. Inside Diameter.

Elastic limit	95,000 to 115,000 lbs. per sq. in.
Ultimate strength	125,000 to 140,000 lbs. per sq. in.
Elongation in 2 in.	Minimum, 15 per cent.
Reduction of area	Minimum, 35 per cent.

Tires 56 In. Inside Diameter and Under.

Elastic limit	110,000 to 125,000 lbs. per sq. in.
Ultimate strength	140,000 to 160,000 lbs. per sq. in.
Elongation in 2 in.	Minimum, 12 per cent.
Reduction of area	Minimum, 30 per cent.

The elastic limit to be obtained by means of an approved extensometer. The ultimate strength is not to be considered as

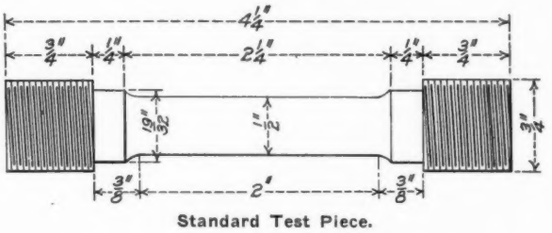


Location at Which the Test Specimen Shall Be Taken.

a requirement, but must in all cases be reported, and should approximate the above ranges.

5. The standard turned test specimen, as shown in the illustration, ½ in. in diameter and 2 in. gage length, shall be used to determine the physical properties as specified in Paragraph 4.

6. Should a falling weight test be required, one tire from each heat shall be selected and tested as described in Paragraph 10. When such a test is made, the tensile test specimen to determine if the steel meets the physical requirements of Paragraph 4 shall be cut cold from the tested steel. The location of this test specimen shall be midway between the tread and the bore and midway



Standard Test Piece.

between the face of the tire and a line passing through the center of the tire from tread to bore, as shown below.

7. Should no falling weight test be required by the contract, the physical properties of each heat of steel shall be determined by a test specimen cut from a bar 6 in. x 4 in. x 9 in., forged from an ingot, and heat treated with the tires. The location of this test specimen to correspond to location of test piece when taken from a tire.

8. When required, the purchaser or his representative shall be furnished with copies of all chemical analyses and physical tests, and be privileged to witness all physical tests.

9. *Heat-Treatment:* The heat-treatment shall consist in reheating the tires after rolling, and then quenching in oil; the tires to be then reheated slowly and uniformly to a temperature sufficiently high to obtain the desired physical properties. The tire must be held at this final temperature at least two hours. The tire should then be withdrawn from the furnace and allowed

to cool in still air. The recommended temperature for quenching is about 1,600 deg. F. The final heating for obtaining the physical properties specified should be approximately 1,100 to 1,200 deg. F.

10. Should the contract call for a falling weight test, a test tire from each heat represented shall be selected by the purchaser or his representative, and furnished at his expense, provided it meets the requirements.

The test tire shall be placed vertically in a running position under the drop, on a solid foundation with an anvil weighing at least ten tons, and shall be subjected to successive blows from a tup weighing 2,240 lbs., falling from heights of 10 ft., 15 ft. and 20 ft. and upwards until the required deflection is obtained as specified below.

The test tire shall stand the drop test described in foregoing paragraph without breaking or cracking and shall show a minimum deflection equal to $D^2 \div (40T^2 + 2D)$, D being the internal diameter in inches and T the thickness of the tire at center of tread in inches. Should the test tire fail to meet the requirements in any particular, two more test tires shall be selected from the same heat, if the manufacturer so desires, and at his expense. Should these two tires fulfill the requirements, the heat shall be accepted.

11. Tires when furnished in the rough shall conform to drawings with the following tolerances:

(a) The height of flange shall not be more than 3-22 in. over or under the height called for. (b) The width of flange shall not be more than 1-16 in. over or under the dimensions called for. (c) The throat radius shall not be more than ⅛ in. greater nor more than 1-16 in. less than the radius called for. (d) The width of tire shall not be more than ⅛ in. greater nor more than 1/16 in. less than the width called for. (e) The inside diameter shall not be less than the diameter of the finished tire by more than ⅜ in. (f) Tires 33 in. or less in inside diameter shall be furnished in sets not varying more than 1-16 in. in outside diameters, and not out of round more than 1-16 in. Tires over 33 in. in inside diameter shall be furnished in sets not varying more than 3-32 in. in outside diameter and not out of round more than 3-32 in.

12. The manufacturer's brand and serial number shall be legibly stamped on the tire close to the inside edge where the stamping will not be cut off at the last turning. Set numbers shall be stenciled on each tire.

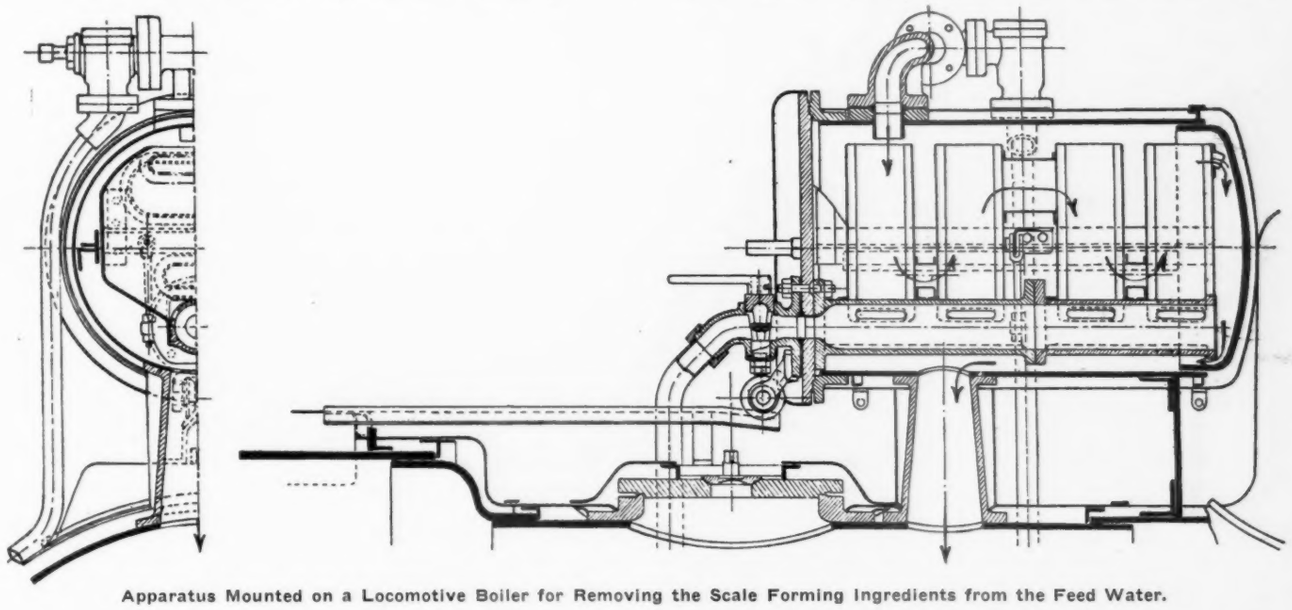
13. The inspector representing the purchaser shall have free entry at all times, while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the tires are being furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

14. Tires which show injurious defects while being finished by the purchaser will be rejected, and the manufacturer shall replace them at his own expense.

DEVICE FOR PREVENTING SCALE

For the past year the State Railways of Hungary have been using an apparatus to prevent scale forming in the locomotive boilers. The action of the apparatus, which was illustrated in a recent issue of the *Revue Generale des Chemins-de-fer*, is based on the well known fact that if the feed water is suddenly raised to a temperature of about 195 deg. Fahr., any carbonate of lime held in solution will be precipitated. There are a large number of arrangements of this kind in use in stationary plants where the sudden heating of the water is effected either by live or exhaust steam. On locomotives, various arrangements have also been used, notably that of Golsdorf.

The Hungarian apparatus is placed on the shell of the boiler with which it is in communication through a large connection. The feedwater enters at the top and circulates in the direction of the arrows. It is heated by the steam that fills the apparatus; the scale is precipitated and falls into the conduit below the four chambers, whence it can be removed under pressure through the valve shown at the left. The water, freed from its carbonate of lime, flows out of the last chamber and drops down to the bottom of the drum and then flows into the boiler. The apparatus possesses the very decided advantage of being independent of and separate from the boiler, so that it may be readily inspected and cleaned; to do this it is only necessary to unbolt the cover and take it off by rolling it back on the rails provided. The conduit and the circulating chambers are connected to this head. In practice it has been found necessary to clean the apparatus with every washing out of the boiler, which however are only half as frequent as formerly. The interior of the boiler is not entirely free from scale, but the scale is readily loosened by the stream from the washout pump.



Apparatus Mounted on a Locomotive Boiler for Removing the Scale Forming Ingredients from the Feed Water.

TABULAR COMPARISON OF TYPICAL LOCOMOTIVES OF THE MOUNTAIN, PACIFIC AND PRAIRIE TYPES

ARRANGED IN ORDER OF TOTAL WEIGHTS IN EACH TYPE

Type	4-6-2	4-8-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	2-6-2	2-6-2
Name of road	D.&H.	C. & O.	P.R.R.	D.L.&W.	P.R.R.	Experim'tal.	N.Y.C.	Santa Fe	O.R.&N.	B.&O.	St.L.&S.F.	B.R.&P.	M.S.P.&S.	N.C.&S.L.	C.&N.W.	C. of G.	S. P.	C.B.&Q.	C.M.&S.P.
Road number or class	P	316	K 29 s	1106	K 2 s	50000	3426	1355	209	P-1	1058	601	731	330	1543	1655	908	R 5	K 1
Builder	AMER.	Amer.	Amer.	Amer.	R. R. Co.	Amer.	Amer.	Baldwin	Baldwin	Baldwin	Amer.	Amer.	Amer.	Baldwin	Amer.	Baldwin	Baldwin	Baldwin	Amer.
When built	1914	1911	1912	1912	1911	1911	1911	1912	1911	1911	1912	1912	1911	1912	1910	1912	1912	1906	1909
Tractive effort, lbs.	41350	58,000	43,300	40,800	30,700	40,800	30,900	34,000	38,700	43,400	40,800	36,300	33,200	35,000	37,700	32,800	30,000	35,070	33,300
Weight, total, lbs.	293500	330,000	317,000	284,000	272,000	269,000	269,000	268,500	265,400	263,800	260,500	258,000	258,000	253,550	250,500	222,300	221,000	216,000	208,000
Weight on drivers, lbs.	191000	239,000	197,800	179,500	178,500	172,500	171,500	163,500	164,850	166,200	158,000	163,500	158,000	157,250	154,500	134,850	141,500	159,540	151,500
Weight on truck, lbs.	47500	44,000	50,500	50,000	47,500	49,500	50,000	54,600	50,150	52,400	55,000	49,000	53,000	51,650	51,000	43,150	37,600	22,800	23,000
Weight on trailer, lbs.	55000	47,000	68,700	54,500	46,000	47,000	47,500	50,700	50,400	45,200	47,500	45,500	47,000	44,650	45,000	44,300	42,000	33,660	33,500
Weight of tender, loaded, lbs.	166500	173,400	175,700	159,600	158,000	161,500	155,200	171,500	169,600	176,200	163,200	169,300	143,200	156,450	157,900	137,300	160,900	152,000	155,300
Wheel base, driving, ft. & in.	13'-0"	16—6	13—10	13—0	13—10	14—0	14—0	13—8	13—4	13—0	12—6	13—0	13—6	13—0	13—6	12—0	13—4	13—4½	11—0
Wheel base, total engine, ft. & in.	34'-10"	37—5	36—5	34—10	35—2½	35—7	36—6	35—1	35—8	34—8	33—1	33—3	34—7	34—1	34—7	31—6	33—4	30—8½	29—3
Wheel base, engine and tender, ft. & in.	70-5¾	70—6	71—5¾	69—0	70—½	68—2½	67—11	61—11	65—7½	70—10⅝	64—9	65—11	66—2¼	67—10	66—10½	63—9½	68—6¼	62—2¾	59—9¼
Diameter of drivers, in.	69"	62	80	73	80	79	79	73	77	74	69	73	75	72	75	69	77	69	63
Cylinders, number	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter, in.	24"	29	27	25	24	27	23½	17½ & 29	25	24	26	24½	25	23	25	23	22	22	21
Cylinders, stroke, in.	28	28	28	28	26	28	26	28	28	32	28	26	26	28	28	28	28	28	28
Valve gear, type	WALS.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Steph.	Wals.
Steam pressure, lbs.	205	180	200	200	205	185	200	210	200	205	175	200	180	200	190	180	200	210	200
Boiler, type	WOOTEN CONICAL	Conical	Conical	Wooten	Belpaire	Conical	Conical	E. W. T.	E. W. T.	Conical	E. W. T.	Conical	E. W. T.	Conical	E. W. T.	Str.	Str.	E. W. T.	Conical
Boiler, smallest diameter, in.	76	83¾	81¾	78	78	79	72	70	74	78	74	74	72	76	70⅞	70	70	70	72
Tubes, number and diameter in inches	252-2"	243—2¼	241—2¼	252—2	202—2¼	207—2¼	175—2¼	199—2¼	356—2¼	389—2¼	247—2	240—2	217—2	440—2	212—2	194—2	173—2	303—2¼	302—2
Flues, number and diameter in inches	34-5½"	40—5½	40—5½	34—5⅜	32—5½	36—5½	32—5	26—5½	.....	.....	32—5⅜	32—5⅜	32—5⅜	.....	30—5⅜	28—5⅜	24—5⅜	.....	.....
Length of tubes and flues, ft. & in.	20'-0"	19—0	22—0	20—0	20—10⅛	22—0	21—6	21—0	22—0	21—0	20—0	20—0	21—0	20—6	20—0	18—0	20—0	19—0	13—2⅛
Heating surface, tubes & flues, sq. ft.	3579	3,795	4,372	3,579	3,453	3,800	3,192.9	3,233	4,593	4,789	3,471.50	3,394.4	3,315	4,703	3,092	2,526	2,477	3,370	2,082
Heating surface, firebox, sq. ft.	317	337	253	239	199	248	231.2	210	235	228	204.28	240.2	207	280	209	163	181	190	285 ✱
Heating surface, total, sq. ft.	3896	4,132	4,625	3,818	3,652	4,048	3,424.1	3,443	4,860	5,017	3,675.78	3,635.0	3,522	4,983	3,328	2,689	2,658	3,560	2,367 ✱
Heating surface, superheater, sq. ft.	796	845	988	821	965	897	765	619	.....	.....	758.60	757.0	805	.....	691	605	580	.....	.....
Grate area, sq. ft.	99.37	66.7	66.1	94.8	55.4	59.75	56.5	57.6	70	70	50.9	56.4	52.8	66.7	52.7	50	49.5	55	44
Firebox, length, in.	132⅛	114⅛	120⅛	126	110¾	114⅛	108⅛	109⅝	120	120	108	108	108⅛	114⅛	108⅛	132	108	108⅛	107
Firebox, width, in.	108"	84¼	79¼	108¼	72	75¼	75¼	76¼	84	84	68½	75¼	70¼	84¼	70¼	84	66	72¼	59
Kind of fuel	ANTHRACITE	Bit. coal	Bit. coal	Anth. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Lignite	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal
Tender, coal capacity, tons	14	15	13¾	14	13	14	12	12	15	16	14	15	12	14	12	13	2,940 g.	16	14
Tender, water capacity, gals.	8000	9,000	8,280	8,000	7,000	8,000	7,500	9,000	9,000	9,500	8,100	9,000	7,500	8,500	8,275	7,500	9,000	8,000	8,000
Weight on drivers ÷ tractive effort	4.62	4.13	4.56	4.40	5.81	4.24	5.55	4.80	4.25	3.84	3.88	4.50	4.80	4.50	4.10	4.12	4.72	4.56	4.55
Weight on drivers ÷ total weight, per cent	65.10	72.60	62.40	63.30	65.60	64.00	63.60	60.80	64.50	63.30	60.60	66.00	64.20	62.10	60.60	60.70	64.20	73.90	73.00
Evap. heat. surf. ÷ superheater heat. surf.	4.89	4.88	4.63	4.64	3.78	4.50	4.48	5.57	.....	.....	4.64	4.80	4.38	.....	4.82	4.46	4.58	.....	.....
Firebox heat. surf. ÷ total heat. surf., per ct.	8.14	8.17	5.48	6.30	5.46	6.14	6.72	6.10	4.83	4.55	5.56	6.62	5.88	5.63	6.30	6.05	6.82	5.34	12.00
Firebox heat. surf. ÷ grate area	3.19	5.05	3.82	2.53	3.60	4.14	4.08	3.64	3.36	3.26	4.02	4.26	3.92	4.20	3.98	3.26	3.66	3.46	6.50
Total heat. surf. ÷ grate area	39.23	62.00	70.00	40.30	66.00	67.70	60.70	59.80	69.50	71.60	72.00	64.50	66.80	74.70	63.20	53.90	53.60	64.70	53.80
Tractive effort × diam. drivers ÷ heat. surf.	711	870.00	750.00	782.00	673.00	800.00	714.00	721.00	610.00	640.00	766.00	730.00	706.00	506.00	849.00	840.00	871.00	679.00	887.00
Total weight ÷ total heat. surf.	75.30	80.00	68.70	74.50	74.50	66.60	78.60	78.00	54.60	52.50	71.10	71.00	73.20	51.00	75.10	82.60	83.00	60.60	87.80
Volume of cylinders, cu. ft.	14.62	21.40	18.54	15.90	13.58	18.54	13.04	12.62*	15.90	16.76	17.20	14.20	14.76	13.44	15.90	13.44	12.32	12.32	11.20
Total heat. surf. ÷ cylinder volume	266.48	193.00	250.00	240.00	269.00	218.00	262.00	272.00	306.00	300.00	218.00	256.00	239.00	370.00	210.00	200.00	215.00	288.00	212.00
Grate area ÷ cylinder volume	6.79	3.12	3.56	5.96	4.08	3.22	4.34	4.57	4.40	4.18	2.96	3.96	3.58	4.95	3.32	3.72	4.01	4.45	3.82
Reference for photograph, drawings or description		Am.Engr. 1911-p381	Loc. Dic. 1912-p183	Am.Engr. 1912-p391	Loc. Dic. 1912-p182	Am.Engr. 1912-p5	Am.Engr. 1911-p133	Am.Engr. 1912-p517	Am.Engr. 1911-p256	Am.Engr. 1911-p143	Am.Engr. 1912-p189	Am.Engr. 1912-p251	Am.Engr. 1911-p310	Am.Engr. 1912-p141	Am.Engr. 1911-p56	Am.Engr. 1912-p372	.....	Loc. Dic. 1912-p169	Loc. Dic. 1912-p169

*Equivalent simple cylinders.

✱ = HEATING SURFACE NOT INCLUDING WATER BARS -

TABULAR COMPARISON OF RECENT LOCOMOTIVES OF THE ATLANTIC, TEN-WHEEL, MOGUL AND SWITCHING TYPES

ARRANGED IN ORDER OF TOTAL WEIGHTS IN EACH TYPE

Type	ATLANTIC (4-4-2)					TEN WHEEL (4-6-0)				MOGUL (2-6-0)		0-10-0	0-8-0	0-8-0	0-6-0	0-8-0	0-6-0	0-6-0
Name of road	P. R. R.	Santa Fe	C.R.I.&P.	Sou. Pac.	Mo. Pac.	D.&H.	M.&St.L.	Can.Nor.	N.W.P.	Vandalia	D.L.&W.	N.Y.C.	D.L.&W.	C.&W.I.	N. Y. C.	A.C.&I.	Southern	U. P.
Road number or class	E 6 s	1485	W-28	3048	5531	D 3 b	350	280	132	158	545	M 4	185	105	253	13	1728	1211
Builder	R. R. Co.	Baldwin	Amer.	Baldwin	Amer.	Amer.	Baldwin	Amer.	Amer.	Amer.	Amer.	Amer.	Amer.	Lima	Amer.	Baldwin	Lima	Baldwin
When built	1912	1910	1910	1911	1912	1912	1909	1911	1910	1907	1909	1907	1910	1911	1906	1910	.....	1906
Tractive effort, lbs	27,470	23,800	29,600	23,500	24,990	31,500	31,000	28,900	30,200	33,300	29,480	55,360	53,800	43,290	44,100	41,200	32,000	27,475
Weight, total, lbs	237,000	231,675	202,000	196,000	191,000	199,000	173,850	173,000	169,000	187,000	171,500	274,000	229,000	201,000	176,500	165,000	145,500	142,800
Weight on drivers, lbs	139,500	112,125	116,000	105,000	115,000	147,500	132,900	133,000	127,000	159,000	150,500	274,000	229,000	201,000	176,500	165,000	145,500	142,800
Weight on truck, lbs	49,000	62,225	49,000	45,000	42,000	51,500	40,950	40,000	42,000	27,700	21,000	.....	.....	.....	.....	.....	.....	.....
Weight on trailer, lbs	48,500	57,325	37,000	46,000	34,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Weight of tender, loaded, lbs	158,000	163,325	149,900	159,000	146,500	145,500	121,150	123,650	119,100	146,000	129,300	151,700	134,000	141,500	129,000	100,000	93,300	92,200
Wheel base, driving, ft. & in	7—5	6—10	7—0	7—0	7—6	15—0	15—10	14—6	14—10	14—9	15—0	19—0	16—0	15—6	12—0	15—4	11—0	11—0
Wheel base, total engine, ft. & in	29—7½	32—8	30—10	27—7	29—8	26—9	26—11	24—10	25—11	23—10	23—10	19—0	16—0	15—6	12—0	15—4	11—0	11—0
Wheel base, engine and tender, ft. & in	63—8	61—1	62—8	58—2	59—7⅛	58—1½	54—3¾	54—3	55—1¾	56—10¼	52—7½	54—7½	49—2¾	51—4	47—2¼	45—7½	43—4¾	42—8½
Diameter of drivers, in	80	73	73	81	78	63	68	63	63	63	63	52	57	57	51	51	51	51
Cylinders, number	2	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter, in	22	15 & 25	17½	20	21	23	21	22	20	21	20½	24	27	24	21	21	20	19
Cylinders, stroke, in	26	26	26	28	28	26	26	26	28	28	26	28	30	28	30	28	26	26
Valve gear, type	Wals.	Wals.	Wals.	Steph.	Steph.	Wals.	Wals.	Wals.	Steph.	Wals.	Wals.	Wals.	Steph.	Steph.	Steph.	Steph.	Steph.	Steph.
Steam pressure, lbs	205	220	160	200	200	170	200	170	200	200	200	210	165	180	200	200	185	175
Boiler, type	Belpaire	W. T.	E. W. T.	Str.	.....	E. W. T.	E. W. T.	Conical	E. W. T.	Str.	Str.	Conical	Str.	E. W. T.	Str.	Str.	E. W. T.	Str.
Boiler, smallest diameter, in	76⅜	72	68⅛	70	68	66¼	66⅜	66	66⅞	77	66	80⅞	83½	74⅜	80	68	63	65
Tubes, number and diameter in inches	242—2	273—2¼	206—2	297—2	362—2	206—2	316—2	185—2	351—2	390—2	310—2	446—2	450—2	327—2¼	430—2	276—2	302—2	237—2
Flues, number and diameter in inches	36—5⅜	Note	24—5¼	.....	.....	28—5⅜	.....	26—5⅜	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Length of tubes and flues, ft. & in	13—8⅝	14—6	18—0	16—0	16—⅛	14—6	15—½	13—2¼	14—2	13—7	13—6	19—0	15—0	14—9½	13—0	16—0	15—1½	11—6
Heating surface, tubes & flues, sq. ft	2,433.2	2,318	2,521.0	2,475.0	3,012.0	2,120.0	2,473.0	1,746.0	2,583.3	2,754.6	2,176	4,416.0	3,514.7	2,832.1	2,906	2,300	2,376	1,416.7
Heating surface, firebox, sq. ft	218.0	190	194.5	179.8	182.5	150.7	176.0	183.0	173.5	180.4	161	186.2	194.6	165.9	206	139	110	146.3
Heating surface, total, sq. ft	2,651.2	2,508	2,715.5	2,654.8	3,194.5	2,270.7	2,649.0	1,929.0	2,761.8	2,935.0	2,337	4,602.2	3,709.3	2,998.0	3,112	2,439	2,486	1,563.0
Heating surface, superheater, sq. ft	653.0	Note	479.0	.....	.....	461.0	.....	403.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Grate area, sq. ft	55	48	42.8	49.5	44.5	50.2	42.5	31.6	30.3	52	53.4	55	58.1	41.2	33.3	44	29	30.2
Firebox, length, in	110¼	109⅝	102⅞	108	96.0	96	90	113¼	108¼	108	102	108¼	111⅛	108	120	96⅛	65⅛	108
Firebox, width, in	72	63⅜	60⅜	66	67.0	75¼	68	40¼	40¼	69	75	73¼	75¼	60¼	40	66	65¼	40¼
Kind of fuel	Bit. coal	Oil	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit coal	Bit. coal	Bit. coal
Tender, coal capacity, tons	13	3,300 g.	13	2,835 g.	14	14	10	10	2,000 g.	13	10	12	10	11	10	11	7	6
Tender, water capacity, gals	7,000	9,000	7,500	9,000	7,000	6,800	6,500	6,000	6,000	7,500	6,500	8,000	7,000	7,400	7,185	5,000	4,500	4,000
Weight on drivers ÷ tractive effort	5.1	4.7	3.92	4.47	4.6	4.68	4.3	4.6	4.2	4.76	5.1	4.45	4.28	4.64	4.00	4.00	4.54	5.2
Weight on drivers ÷ total weight, per cent.	58.80	48.60	57.50	53.70	60.20	73.80	76.50	78.60	75.00	85.00	88.00	.....	.....	.....	.....	.....	.....	.....
Evap. heat. surf. ÷ superheater heat. surf.	4.05	.....	5.68	.....	.....	4.92	.....	4.79	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Firebox heat. surf. ÷ total heat. surf., per ct.	8.20	7.50	7.18	6.75	5.72	6.67	6.68	9.50	6.30	6.13	6.80	4.03	5.24	5.52	6.60	5.71	4.42	9.35
Firebox heat. surf. ÷ grate area	3.97	3.97	4.54	3.63	4.10	3.00	4.14	5.80	5.70	3.48	3.02	3.40	3.36	4.03	6.18	3.16	3.80	4.85
Total heat. surf. ÷ grate area	48.30	52.20	63.40	53.80	71.80	45.00	62.40	61.00	91.00	56.50	43.60	84.00	63.80	72.70	93.50	55.20	86.00	51.90
Tractive effort × diam. drivers ÷ heat. surf.	828.00	692.70	798.00	717.00	609.00	875.00	797.00	945.00	688.00	717.00	795.00	625.00	825.00	823.00	722.00	863.00	655.00	895.00
Total weight ÷ total heat. surf.	89.30	92.50	74.50	73.80	59.70	88.00	65.60	89.50	61.30	63.80	73.50	59.50	61.80	67.00	56.70	67.50	58.50	91.30
Volume of cylinders, cu. ft	11.40	8.30*	14.43	10.15	11.20	12.45	10.40	11.40	10.15	11.20	9.95	14.66	19.90	14.66	12.00	11.20	9.50	8.60
Total heat. surf. ÷ cylinder volume	233.00	302.00	188.00	262.00	285.00	182.00	255.00	169.00	273.00	262.00	234.00	314.00	186.50	204.00	259.00	218.00	262.00	182.00
Grate area ÷ cylinder volume	4.82	5.70	2.97	4.92	3.98	4.03	4.09	2.77	3.02	4.65	5.38	3.75	2.93	2.81	2.77	3.93	3.04	3.51
Reference for photograph, elevation or description	Am.Engr. 1911-p124†	Am.Engr. 1911-p44	Loc. Dic. 1912-p180	Loc. Dic. 1912-p179	Loc. Dic. 1912-p179	Loc. Dic. 1912-p225	Loc. Dic. 1912-p181	Loc. Dic. 1912-p180	Loc. Dic. 1912-p181	.....	Loc. Dic. 1912-p168	Loc. Dic. 1912-p164	Loc. Dic. 1912-p163	Am. Engr. 1911-p457	Loc. Dic. 1912-p161	Loc. Dic. 1912-p164	Loc. Dic. 1912-p204	Loc. Dic. 1912-p162

Note—Equipped with reheater having 417 tubes 48 in. long giving a reheating surface of 1,147 sq. ft. *Equivalent simple cylinders. †Reference for locomotives as built without superheater.

LARGE NARROW GAGE LOCOMOTIVES

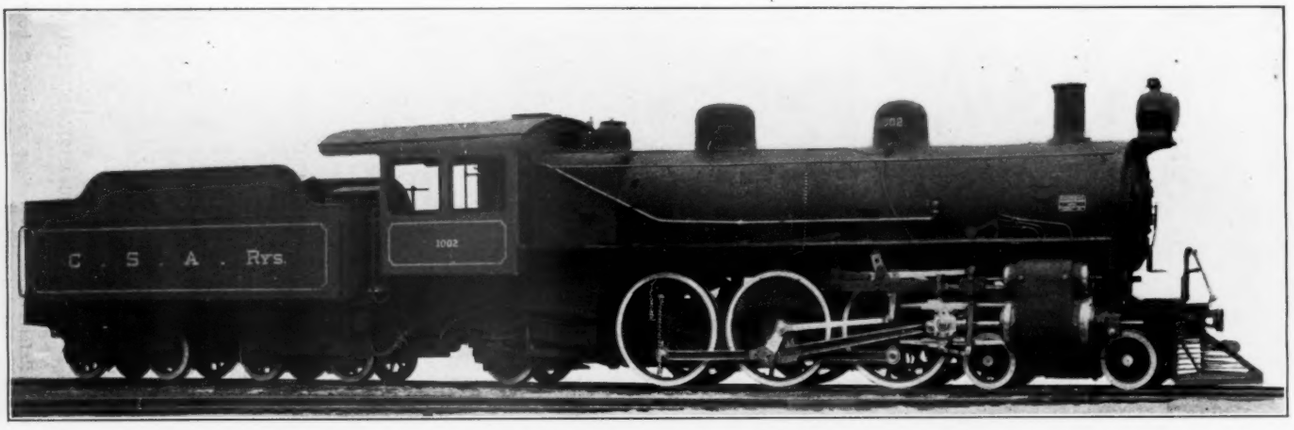
In connection with a description in the December issue of two locomotives of the Garratt type built for the Tasmanian Government Railways, it was stated that these are the largest narrow gage locomotives in the world. We have been informed that this is not correct and that the American Locomotive Company has built both freight and passenger locomotives for the Central South African Railway, a 3 ft. 6 in. gage line, which are larger and more powerful than those of the Garratt type. Furthermore, this company has now under construction a 2-8-8-2 type locomotive for a metre gage line which is even larger and will weigh from 230,000 lbs. to 240,000 lbs. for the engine alone and about 340,000 lbs. for the engine and tender combined, which weight should be used in comparing it with the Garratt type.

In the table below will be found the comparative weights and other dimensions of the Garratt type locomotives and both the freight and passenger locomotives of the Central South African Railways mentioned above. It will be seen that in the case of the freight engines, the Mallet has a weight of 230,000 lbs. for the engine alone and 334,600 lbs. for the engine and tender, which, compared with the Garratt type, is an increase of 14 per cent. in the former item and 65 per cent. in the latter. The tractive effort shows a similar difference, being 48 per cent. larger than that of the Tasmanian engine. The driving wheels are slightly larger and the steam pressure is 200 lbs. as compared with 160 lbs. The heating surface and grate area are also decidedly larger.

In the case of the passenger engines, the Pacific type without the tender has a weight of 155,500 lbs. compared with 211,800 lbs. for the Garratt type, but when the weight of the tender is also included this engine weighs 22 per cent. more than the Tasmanian and the tractive effort is about 10 per cent. greater.

Freight Locomotives.

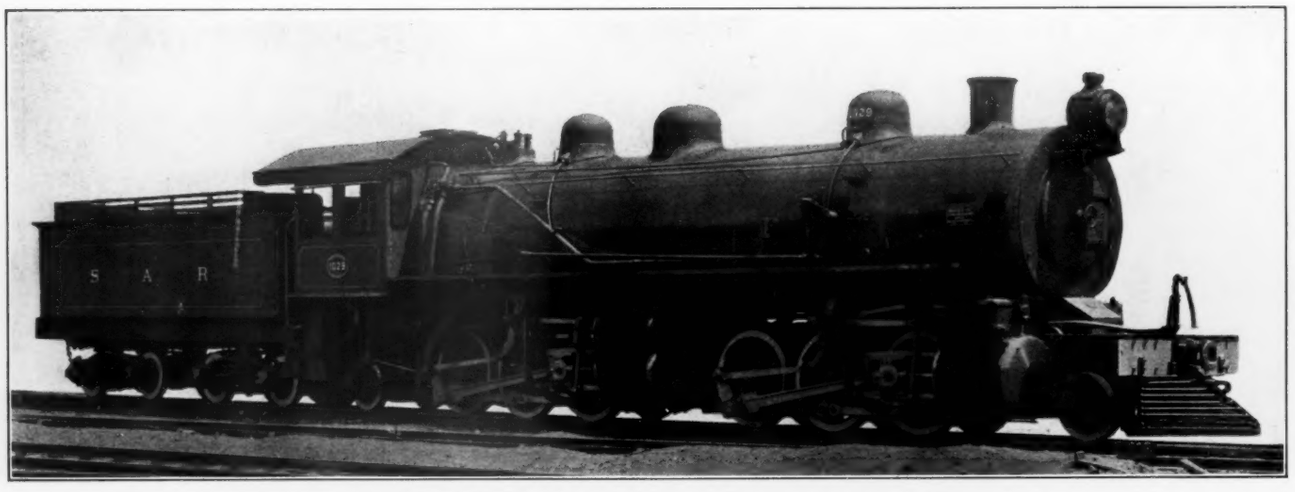
	Tasmanian	So. African Govt.
Type	Garratt	Mallet
Wheel arrangement	2-6-2-2-6-2	2-6-6-2
Total weight, engine, lbs.	201,700	230,000
Total weight, engine and tender, lbs.	201,700	334,600
Weight on drivers, lbs.	.....	196,000
Tractive effort, lbs.	32,100	47,700
Cylinders, number	4	4
Cylinders, diameter and stroke, in.	15x22	18 & 28½x26
Diameter of drivers, in.	42	46
Steam pressure, lbs.	160	200
Total heating surface, sq. ft.	1,686	2,621
Grate area, sq. ft.	39.3	49.3
Tender, water capacity, gals.	3,000*	4,000
Tender, coal capacity, tons.	4*	9



Narrow Gage Pacific Type Locomotive for the Central South African Railways.

Passenger Locomotives.

	Garratt	Pacific
Type	4-4-2-2-4-4	4-6-2
Wheel arrangements	211,800	155,500
Total weight, engine, lbs.	211,800	259,800
Total weight, engine and tender, lbs.	.....	106,000
Weight on drivers, lbs.	26,100	28,800
Tractive effort, lbs.	8	2
Cylinders, number	12x20	21x28
Cylinders, diameter and stroke, in.	60	62
Diameter of drivers, in.	160	170
Steam pressure, lbs.	1,686	1,981
Total heating surface, sq. ft.	39.3	35
Grate area, sq. ft.	3,000*	4,000
Tender, water capacity, gals.	4*	10
Tender, coal capacity, tons.		



Large Narrow Gage Mallet Locomotive for the South African Railways.

*Does not have a separate tender. The tanks are carried on the locomotive frames.

SHOP PRACTICE

LOCOMOTIVE SHOP KINKS

BY LEWIS D. FREEMAN,
Special Tool Designer, Baltimore & Ohio, Baltimore, Md.

METAL PAN FOR HANDLING MATERIAL.

An improved method of handling material in large quantities is illustrated in Fig. 1, which shows a metal pan 6 ft. x 7 ft., made from steel plates ¼ in. thick; it is 15 in. high at the sides with one end open. The top edges are bound with 1⅛ in. half round iron. The labor in handling material with this pan is greatly reduced over that of using a wheel-barrow or cart. Empty pans are loaded at the foundry or the smith shop with the newly made material, and are placed on a cart or truck by a crane and hauled to the machine shop. The pans may then be used to take the finished material to the erecting shop or storehouse.

The general appearance of the shops can be greatly improved

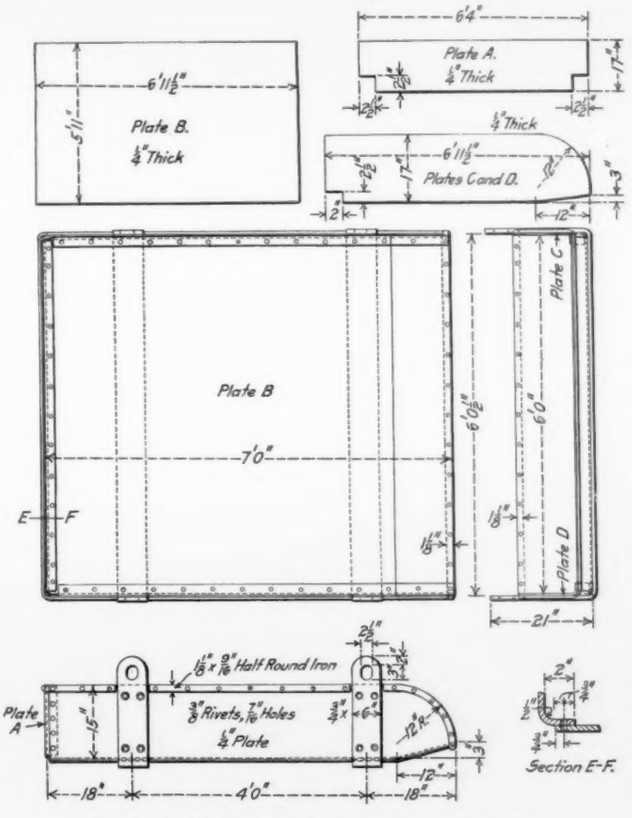


Fig. 1—Metal Pan for Carrying Loose Material.

by placing these pans about the shop where the scrap material can be gathered in them. They can also be used to good advantage when placed so that they will catch the scrap from the shears and punches, and when full can be taken directly to the scrap pile. When carried by a crane the pans should be suspended by four chains having one end attached to a ring and the other to hooks which will fit in the eyes on the pan. With this arrangement the contents of the pan may be dumped by slackening the chains, unhooking the two front chains and lifting up with the two back ones, allowing the contents to fall out at the open end. While this idea is by no means new this pan is of simple, yet strong construction, and more satisfactory than if it were made of wood.

LOCATING BOILER GAGE COCK HOLES.

Recent state and federal laws concerning the operation of locomotive boilers make it necessary to report the exact location of gage cock holes, as well as the necessity of laying out new gage cock holes in rebuilt boilers in a certain relative position to the crown sheet. Many schemes have been developed using straight edges and plumb lines which require the services of three or more men, and they have many chances for error.

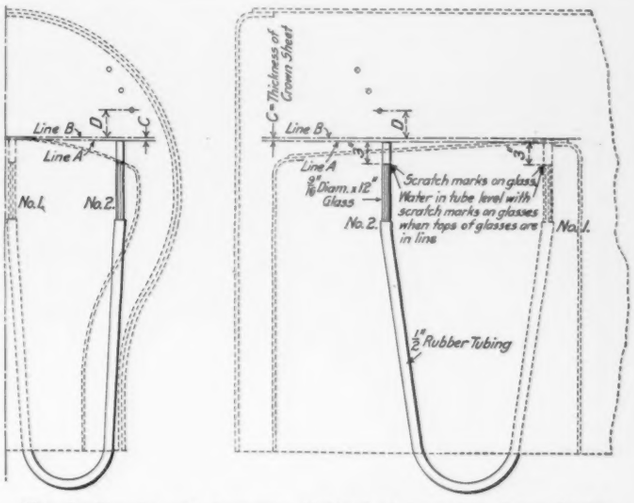


Fig. 2—Simple and Accurate Method of Locating Gage Cocks.

After some study the writer developed the plan shown in Fig. 2, which is similar to the Baldwin Locomotive Works' practice.

Take two water gage glasses about 12 in. long, square up the top ends and with a glass cutter make a scratch around the glasses about 3 in. from the top. Connect the two glasses with a piece of rubber tubing of suitable length, 12 ft. to 18 ft. is usually sufficient for the largest locomotives, and fill it with water up to the scratch marks, having the tops of both glasses in line. Two men are required to operate this device. With the boiler setting approximately level, one man takes glass No. 1 into the firebox, holding it against the highest point of the crown sheet. Glass No. 2 is taken out through the fire door hole or under the sides of the mud ring to the back head or to the side of the boiler, where it is desired to locate the gage cock holes. Raise or lower glass No. 2 until the water is level with the scratch marks in both glasses and scribe the line *A* on the boiler level with the top of glass No. 2. This line *A* represents the lower side of the crown sheet and by laying off the thickness of the crown sheet *C* the line *B*, which represents the highest point of the crown sheet inside of the boiler is obtained. Then measure off the distance *D*, which will be the proper height of the lowest gage cock. The other gage cocks may be easily located from this point. The same method is used to measure the height of any gage cock already in place. Objections have been made against this scheme on account of the possibility of air bubbles affecting the level of the water, but when this gage is once filled with water it should never be emptied. Corks should be placed in the tops of the glasses to prevent evaporation, and each time the device is used, simply hold the tops of the glasses together and see that the water is level with the scratch marks and the gage will then be ready for service.

RIGHT ANGLE EXTENSION FOR AIR MOTORS.

In many places on modern heavy locomotives the reaming of holes with large air motors is practically impossible, especially under the boiler where the holes must be reamed for frame splices, crossties, firebox supports, foot plates, etc. It is necessary either to purchase special air motors which sacrifice power for space or to ream the holes by hand. The right angle extension shown in Fig. 3 was designed to make use of the standard air motors, and at the same time use the square shank hand reamers. By means of drill press extension shanks the air motors may be several feet away from the work. The socket *A* may be replaced by others having different sizes of square holes to fit the different sizes of square shanks on the hand reamers, and in this way eliminate the use of the tapered shank reamers Gears *B* and *C* are helical gears cut to any convenient pitch depending solely on the machine at hand to do the work. All parts of the device are made from machinery steel except parts *D* and *E*, which may be made from either cast iron or brass.

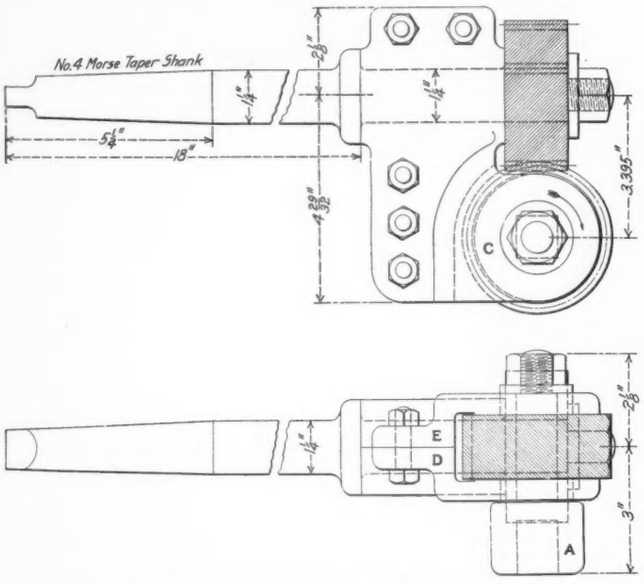
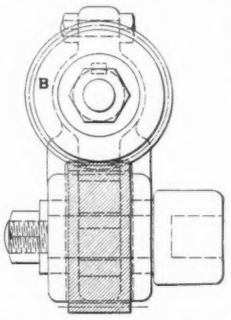


Fig. 3—Right Angle Attachment for Air Motors.



COUNTERSINKING ATTACHMENT FOR DRILL PRESS.

In large railway shops where there are one or more fireboxes made each working day, the countersinking of the holes in the flanges of the back flue sheets and the furnace door sheets becomes a job of no small importance. Most air motors are too large to line up with the holes in the flanges of these sheets, and to do the job with a hand ratchet is very expensive. Fig. 4 shows a device used to do this work on a drill press. Shaft *A* has a Morse taper shank to fit the spindle of the drill press. This shaft drives the shaft *D* through the bevel gears *B* and *C*.

The countersinking shaft *D* is keyed in the driving gear sleeve *C*, having a sliding fit therein, and is fed by the nut *F*, which is threaded into the feed gear sleeve *G*. The feed is operated by hand through the feed gears *H* and *G*. With this device it is possible to get within 1½ in. from the flat surface of the plate, which is as close as the holes are usually placed. This machine works rapidly and does a better job at about one-quarter of the cost of hand work. A variation of this device can also be used to drill the holes in the pedestal jaws of locomotive frames, which are used for the purpose of securing the shoes and wedges, by removing the back stop *E* and adding a fixed center at the back.

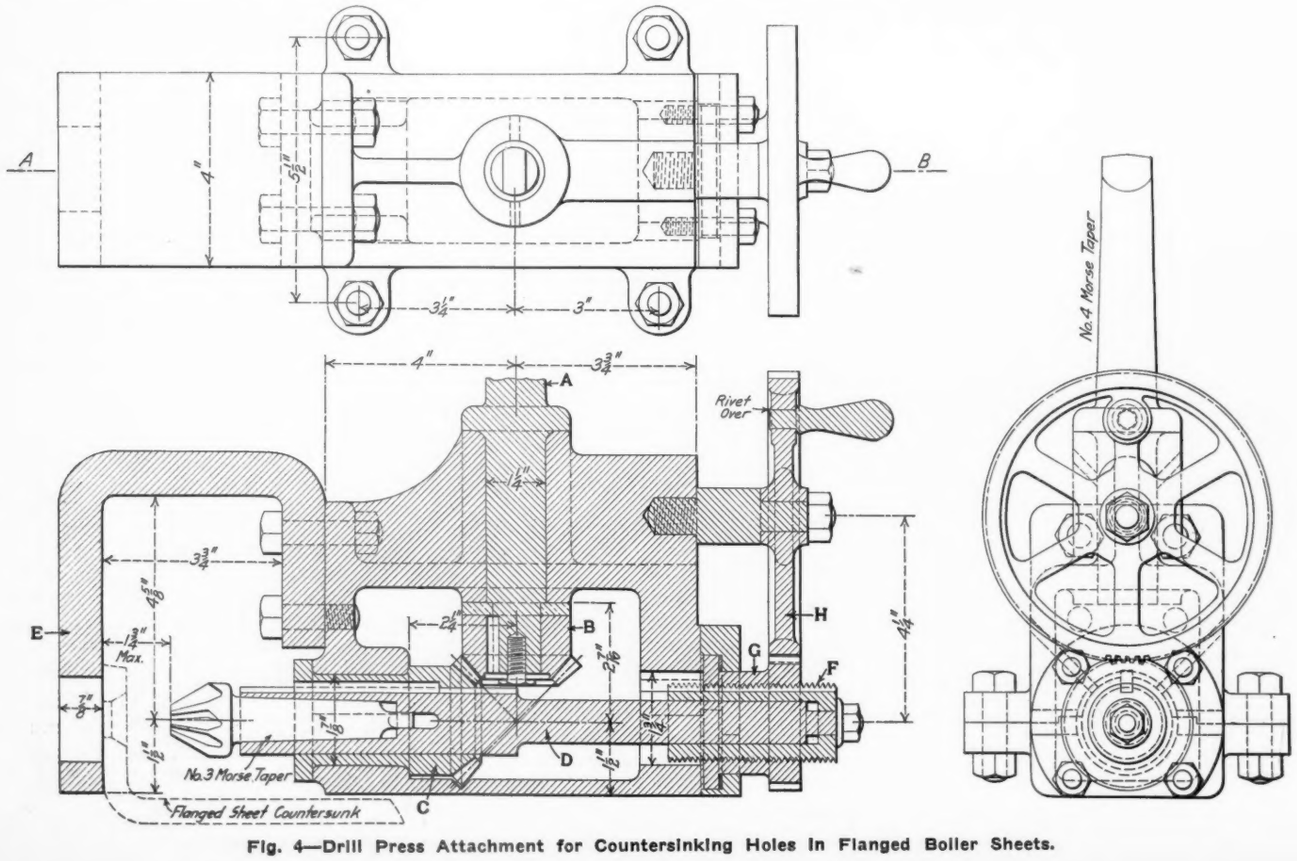


Fig. 4—Drill Press Attachment for Countersinking Holes in Flanged Boiler Sheets.

LOCOMOTIVE BOILER TUBE TOOLS

For Application and Maintenance of All Tubes, Including Those for Superheaters and Brick Arches.

BY WALTER R. HEDEMAN.*

It is not the intention to enter into a discussion of the relative merits of any of the tools or methods described, but simply to tell what tools are giving economical and efficient service in one of the largest railroad repair shops in the United States. It is, however, the writer's belief that the tools and appliances hereinafter described will stand most favorable comparison with any other devices or methods along similar lines.

In the article on "The Care of Boiler Tubes," in the August

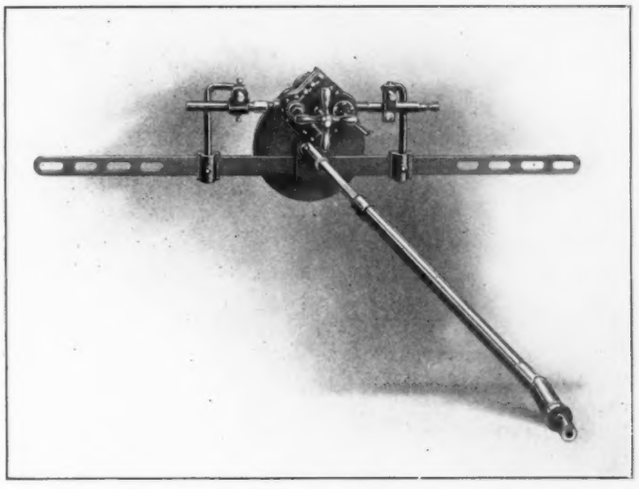


Fig. 1—The Faessler Tube-Cutting Machine with Motor.

number of the *American Engineer,* mention was made of an improved design of flue cutting off machine, to be used in removing flues from boilers. The Faessler tube cutting-off machine for locomotive boilers shown in Fig. 1 is an excellent one for this purpose, and is manufactured by the J. Faessler Manufacturing Company, Moberly, Mo. The use of this machine resulted in a saving of one cent a flue over the previous method of chipping off beads, mashing in ends and starting with a

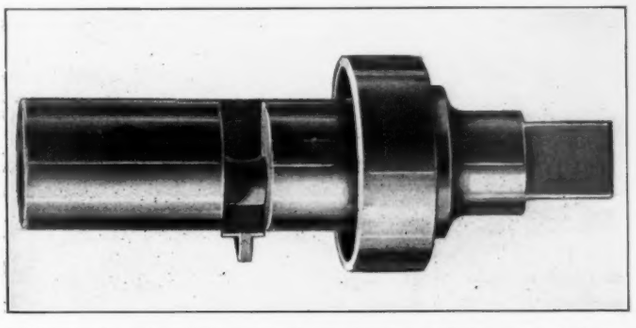


Fig. 3—Faessler Cutter, Used for Cutting Off Flues in Boiler, Preparatory to Removal.

sledge. It is the practice to cut off the flue as close to the sheet as possible without injuring the sheet in order to save as much of the flue as possible. The machine is attached by its crossbar to the front end of the smokebox of the locomotive as shown in Fig. 2, and is held in place by the bolts or studs that hold the smokebox front in place. A No. 22 Thor reversible air machine, of the piston type motor, is used to drive it. A pinion transmits the power from the motor to a gear, which in turn is connected to the cutter proper by means of a telescopic transmission rod and universal joints.

The machine can be quickly attached and detached, reaches all flues without resetting, can be easily operated by one man, and is simple, effective and economical in its work. The working parts are of steel; the gear and pinion are completely enclosed and run in an oil bath, and destructive wear is practically eliminated. Interchangeability of parts is a strong feature of the device. The machine will cut 1¾ in., 2 in., and 2¼ in. tubes, but a different size cutter is required for each size of tube.

The cutter itself is shown in Figs. 3 and 4. It consists of four parts, and turns upon an eccentric shaft, so placed that a quarter turn of the body of the tool forces the knife out far enough

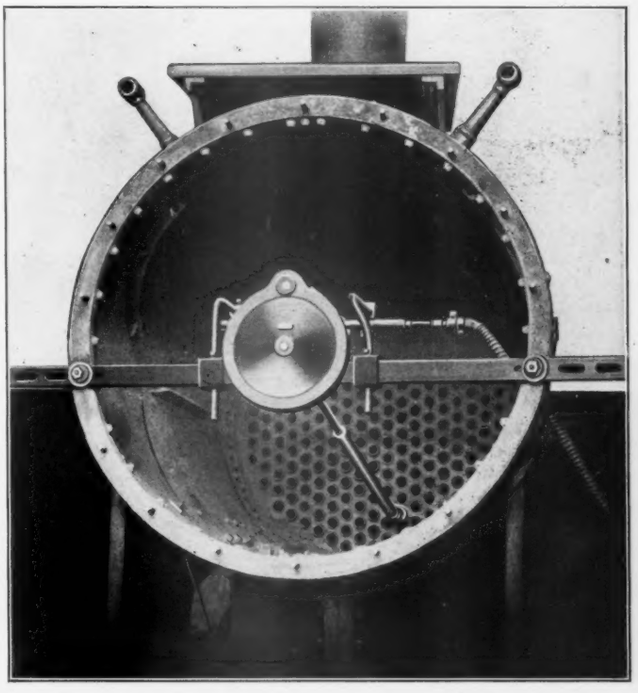


Fig. 2—Application of Faessler Tube-Cutting Machine.

to pierce the flue. One complete revolution cuts the flue. The cutter is then removed by reversing for a quarter turn and withdrawing. It may be operated with a wrench, if necessary.

For heating the flues preparatory to flaring and welding on the safe end a Ferguson flue welding furnace, furnished by the Railway Materials Company, Chicago, is used, and is illustrated in Figs. 5 and 6. It takes up a comparatively small amount of floor space, and maintains an ideal welding temperature, free from oxidation; the capacity is only limited by the skill of the operator. It has a combustion chamber, in which combustion is started, the resulting temperature serving to break down the oil into a gas as it passes upward in the chamber. The flame is directed into the furnace and air is admitted for complete combustion by means of a secondary blast of air introduced at the top of the combustion chamber. This arrangement sup-

*The writer begs to acknowledge the able assistance of R. C. Morton in the preparation of this article.

plies the necessary oxygen at the proper stages for the complete combustion of the gas in the furnace proper.

The furnace is just as hot where the flame enters as it is at any other point. All the breaking up of the oil is performed

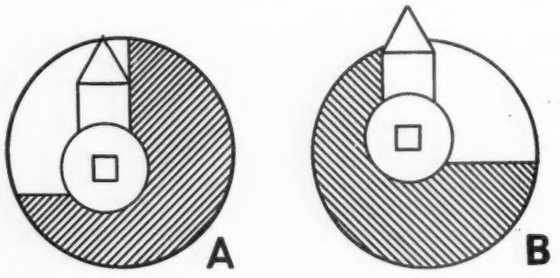


Fig. 4—Diagrammatic View, Showing Arrangement of Faessler Cutter.

outside the heating chamber proper. A fan blast of 8 oz. pressure, and an oil supply at a pressure of from 5 to 10 lbs. should be furnished. An independent regulation of air and oil is ob-

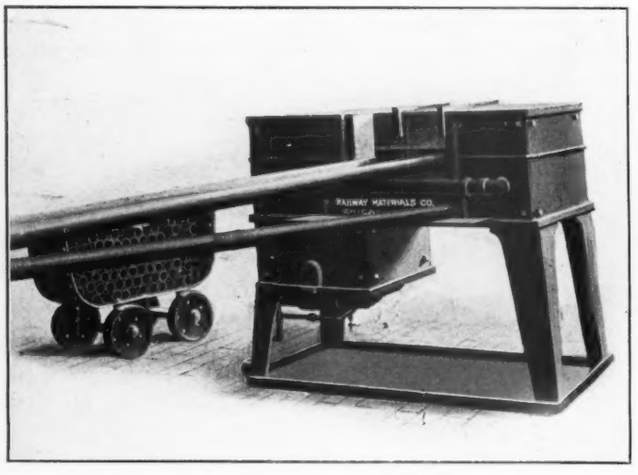


Fig. 5—Ferguson Flue Welding Furnace.

tained by means of a durable machined blast valve, and by a needle point oil valve.

The standard tapered horn for flaring the flue and also the horn for holding the safe-end are shown in Fig. 7. These horns may be fastened to a stand of any suitable construction of cast or wrought iron, and should be located alongside of the furnace.

the flue against it, and then the flue with the safe-end entered is placed in the furnace for reheating preparatory to welding.

For welding and swaging flues the double cylinder welder shown in Fig. 8 made by the Draper Manufacturing Company, Port Huron, Mich., is used.

A 2 in. flue can be welded and swaged with one heat and with a smooth and even weld, inside and out, leaving the flue an even thickness all around. It is obvious that this machine should be placed as close to the furnace as possible. Any length of safe-end can be welded on by having a long mandrel and placing the machine directly behind the

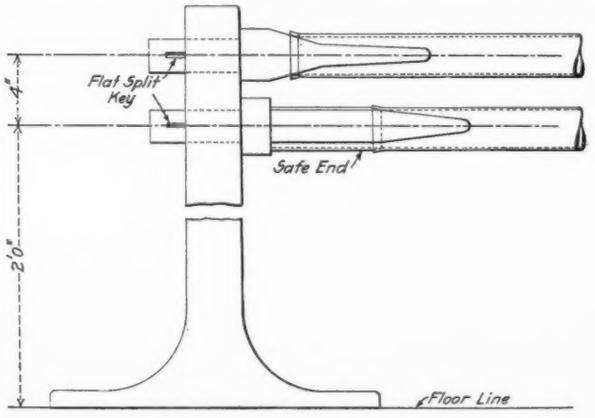


Fig. 7—Horns for Flaring Flues.

furnace, allowing the end of the flue to project through the dies while heating, and when hot shoving it forward until the weld comes under the dies. This machine takes up a floor space of less than two square feet, and strikes 2,000 or more blows per minute with 80 to 100 lbs. air pressure.

After the safe-end is welded on, the flues are cut to the proper length in a machine having revolving disc cutters similar to an ordinary pipe cutter. They are then tested in the flue testing machine which was described on page 484 of the September, 1912, number of the *American Engineer*, after which they are ready for application to the boiler.

For setting the copper ferrules in the firebox tube sheet, the tool shown in Fig. 9 may be used. The ferrules, which should neatly fit the holes, are first entered in the flue sheet and are driven home with the tool and a hand hammer. The dimension is such that the tool will center itself after being entered in the ferrule. Dimension B is made 1/32 in. less than the diameter of the hole in the sheet. By driving the tool in until the wide face

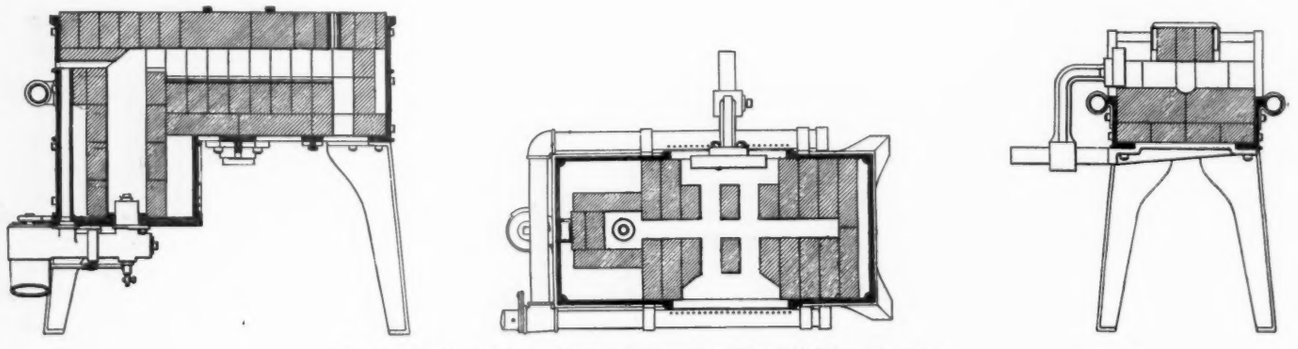


Fig. 6—General Construction of Ferguson Flue Welding Furnace.

After a flue has been heated the operator can flare it sufficiently to allow the scarfed end of the safe-end to enter by ramming it on the top horn two or three times. The scarfed safe end, having previously been placed on the lower horn, can now be picked up by the operator by pressing the flared end of

at the edge presses against face of sheet, the shoulder on the tool insures the ferrule being set 1/32 in. below the face of the sheet. The dimensions for nine sizes of tools are shown in the table, the handle being common to all.

For expanding the copper ferrules the straight sectional ex-

pander shown in Fig. 10 is used. It is made in eight segments and is expanded by means of an octagonal shaped mandrel shown in Fig. 15. The same tool is also used for expanding the firebox end of the flue. The table covers four sizes of expanders and two sizes of mandrels. A long stroke air hammer is used with this tool.

The tool shown in Fig. 11 is being experimented with and can be used for setting and expanding the copper ferrule and expanding the flues. The contour is such as to insure setting the ferrule 1/32 in. below the face of the tube sheet. If good results are obtained with it, the tools shown in Figs. 9 and 10 can be dispensed with. The same mandrel is used as with the expander shown in Fig. 10. The table covers four sizes of expanders, for flues 2 in., 2¼ in., and 2½ in., and their corresponding ferrules. The mandrel seat in the expander is

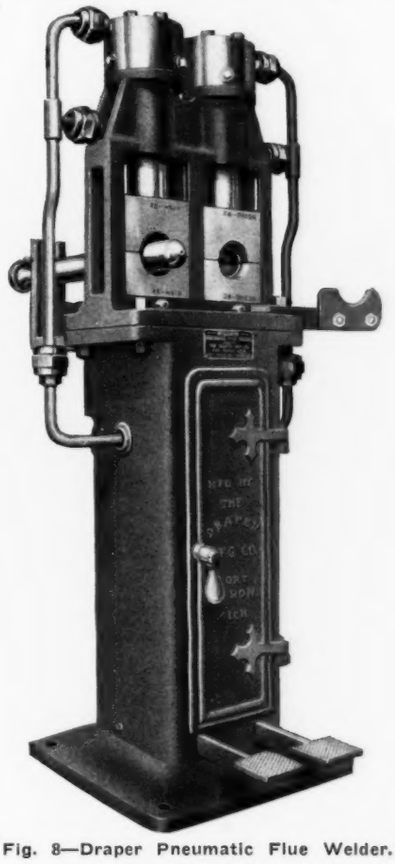


Fig. 8—Draper Pneumatic Flue Welder.

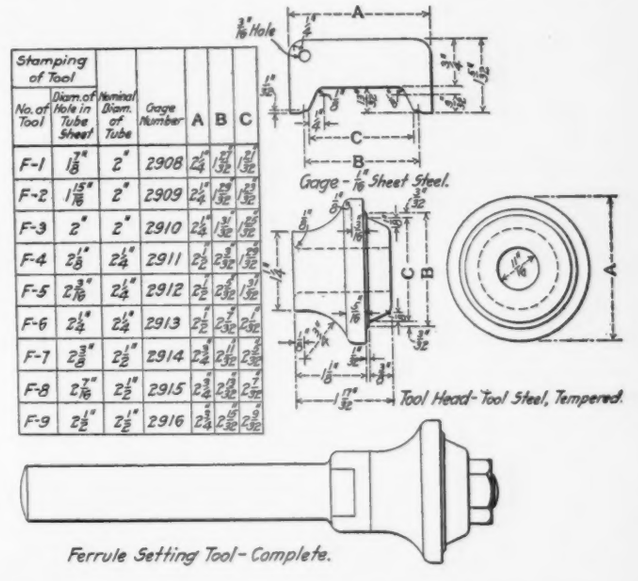
made with a double taper, to permit of the easy removal of the mandrel. The taper on the working end of the expander is the same as the taper on the mandrel, which insures the expander being seated on the mandrel when in operation. A coil spring segment keeper is preferable to one of rubber, as the oil used with these tools causes the rubber to deteriorate.

For flaring flues in the firebox sheet, preparatory to prosser-expanding, the tool shown in Fig. 12 is used, and is operated with a long stroke riveting hammer. The design makes it suitable for the standard sizes of boiler flues.

The tool shown in Fig. 13 is used for prosser-expanding the flues in the firebox sheet. A long stroke riveting hammer is used against the mandrel until the flue is set solid in the hole; then the mandrel is slacked off and the expander is turned slightly; the operation is repeated until the flue is properly set and evenly expanded all the way around. This tool is made in eight segments, and the outer contour is such as to expand a shoulder on the flue immediately inside of the flue sheet. Six different sizes of expanders are shown in the table, and two sizes of mandrels.

Beading tools 3 and 4, which operate with a short stroke air hammer, and are used for beading the flues on the firebox end, the last operation to be performed at this end of the flue, are

Stamping of Tool No.	Diam. of Hole in Tube Sheet	Nominal Diam. of Tube	Gage Number	A	B	C
F-1	1 7/8"	2"	2908	2 1/4"	1 31/32"	1 31/32"
F-2	1 15/16"	2"	2909	2 1/4"	1 29/32"	1 29/32"
F-3	2"	2"	2910	2 1/4"	1 31/32"	1 29/32"
F-4	2 1/8"	2 1/4"	2911	2 1/2"	2 3/32"	1 31/32"
F-5	2 3/16"	2 1/4"	2912	2 1/2"	2 3/32"	1 31/32"
F-6	2 1/4"	2 1/4"	2913	2 1/2"	2 1/32"	2 1/32"
F-7	2 3/8"	2 1/2"	2914	2 3/4"	2 11/32"	2 5/32"
F-8	2 7/16"	2 1/2"	2915	2 3/4"	2 9/32"	2 7/32"
F-9	2 1/2"	2 1/2"	2916	2 3/4"	2 9/32"	2 9/32"



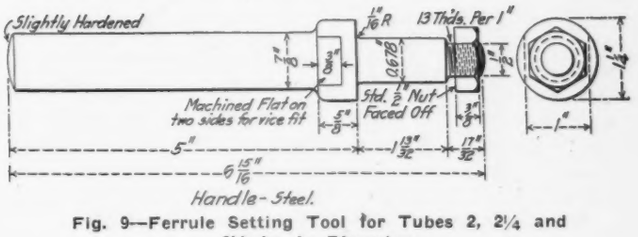


Fig. 9—Ferrule Setting Tool for Tubes 2, 2¼ and 2½ In. in Diameter.

shown in Fig. 14. The only difference in these two tools, is that dimension *Y* is 1/64 in. greater on tool 4 than on tool 3.

For Stamping Number of Tool	Tools Used For: Seating Copper Ferrules in Sheet, Outside Diameter of Ferrules	Tools Used For: Expanding Tubes in Ferrules, Nominal Diam. of Tubes	Number of Segments to Each Expander	A Diam. After Cut	B Diam. After Cut	C Diam. After Cut	Number of Mandrel Used
S-1		2"	8	1 21/64"	1 17/64"	3/8"	M-1
S-2	1 7/8", 1 15/16", 2"	2 1/4"	8	1 37/64"	2 9/64"	3/8"	M-1
S-3	2 1/8", 2 3/16", 2 1/4"	2 1/2"	8	1 53/64"	2 25/64"	9/16"	M-2
S-4	2 3/8", 2 7/16", 2 1/2"		8	2 5/64"	2 41/64"	9/16"	M-2

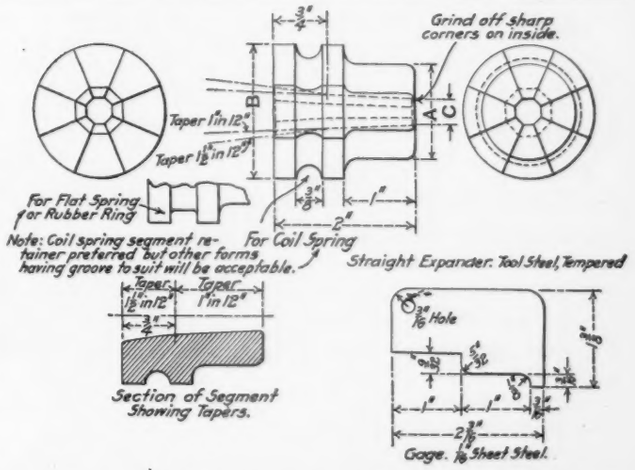


Fig. 10—Straight Sectional Expander for Copper Ferrules and Boiler Tubes.

The mandrel used with the expanders shown in Figs. 10, 11, 13 and 24 is shown in Fig. 15, only two different sizes being required to operate all these expanders. Experience has demonstrated that it is better to make as many sides on the mandrel as the size of the tool will permit. It was found with the old style round mandrel that the segments rode together and would not keep separated, two or more butting together in service; therefore the octagonal mandrel was adopted. A long stroke riveting hammer is used with these mandrels.

For Stamping	Tools Used For		Number of Segments of Each Expander	A	B	C	D	Number of Mandrel Used
	Expanding & Setting Copper Ferrules in Sheet	Expanding Tubes in Ferrules						
Number of Tool	Outside Diameter of Ferrules	Nominal Diam. of Tubes		Diam. After Cut	Diam. After Cut	Diam. After Cut	Diam. After Cut	
S-7		2"	8	1 21/64"	1 29/64"	1 57/64"	3/8"	M-1
S-8	1 7/8", 1 15/16", 2"	2 1/4"	8	1 37/64"	1 45/64"	2 9/64"	3/8"	M-1
S-9	2 1/8", 2 3/16", 2 1/4"	2 1/2"	8	1 53/64"	1 61/64"	2 25/64"	9/16"	M-2
S-10	2 3/8", 2 7/16", 2 1/2"		8	2 5/64"	2 13/64"	2 41/64"	9/16"	M-2

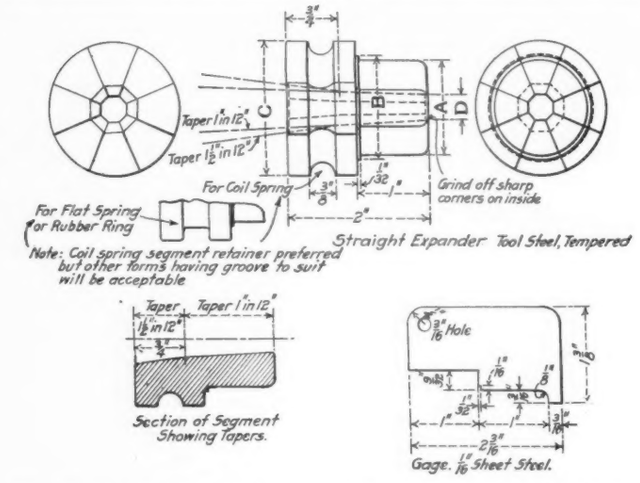

Taper 1 in 12"
Taper 1 1/2 in 12"
For Coil Spring
For Flat Spring or Rubber Ring
Grind off sharp corners on inside
Straight Expander Tool Steel, Tempered
Note: Coil spring segment retainer preferred but other forms having groove to suit will be acceptable
Section of Segment Showing Tapers.
3/16" Hole
Gage. 1/16" Sheet Steel.

Fig. 11—An Experimental Type of Straight Sectional Expander.

A self-feed roller expander, which is used for tightening flues in the front flue sheet is shown in Fig. 16. It is self-feeding by reason of having the center lines of the rollers set at a slight angle with the center line of the mandrel. This arrangement makes the mandrel work into the tool on the screw principle, the inclined rollers and friction between the mandrel and rollers doing the duty of threads. Three different sizes of tools are shown in the table. The mandrel is turned by an air machine.

For Stamping	Tools Used For		Number of Segments to Each Expander	A	B	C	D	Number of Mandrel Used
Number of Tool	Diam. of Hole in Tube Sheet	Nominal Diam. of Tube		After Cut	After Cut	After Cut	After Cut	
P-1	1 7/8"	2"	8	1 11/32"	1 3/16"	1 5/8"	3/8"	M-1
P-2	1 15/16", 2"	2"	8	1 7/16"	1 23/32"	1 23/32"	3/8"	M-1
P-3	2 1/8"	2 1/4"	8	1 19/32"	1 7/16"	1 7/8"	3/8"	M-1
P-4	2 3/16", 2 1/4"	2 1/4"	8	1 11/16"	1 27/32"	1 31/32"	9/16"	M-2
P-5	2 3/8"	2 1/2"	8	1 27/32"	1 11/16"	2 1/8"	9/16"	M-2
P-6	2 7/16", 2 1/2"	2 1/2"	8	1 15/16"	1 25/32"	2 3/32"	9/16"	M-2

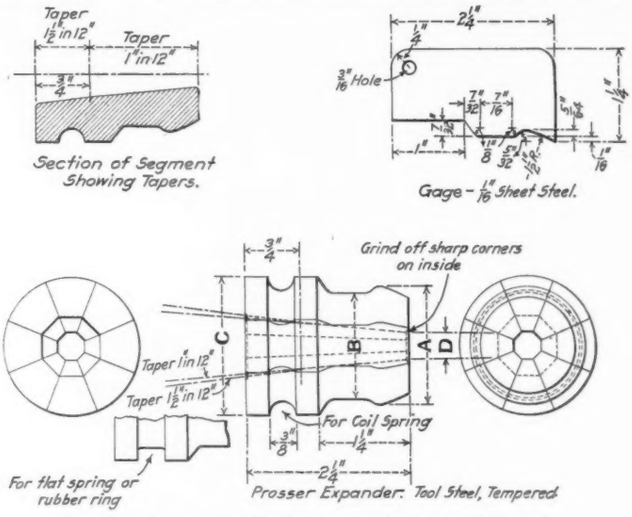

Taper 1/2 in 12"
Taper 1 in 12"
Section of Segment Showing Tapers.
3/16" Hole
Gage - 1/16" Sheet Steel.
Grind off sharp corners on inside
For Coil Spring
For flat spring or rubber ring
Prosser Expander. Tool Steel, Tempered.

Fig. 13—Prossering Expander for Tubes 2, 2¼ and 2½ In. in Diameter.

The manner of setting superheater tubes is shown in Fig. 17.

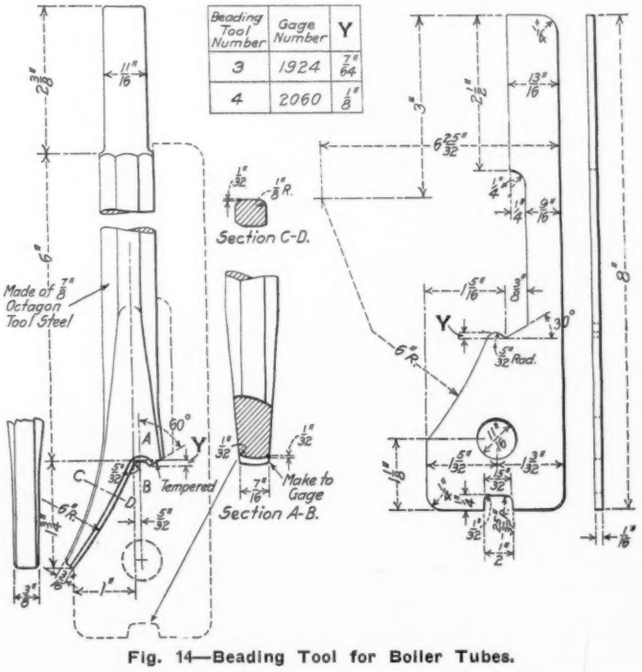


Fig. 14—Beading Tool for Boiler Tubes.

The specifications for these tubes, as well as for the tubes for brick arches, should include all the requirements called for in the article on page 414 of the August, 1912, number of the *Amer-*

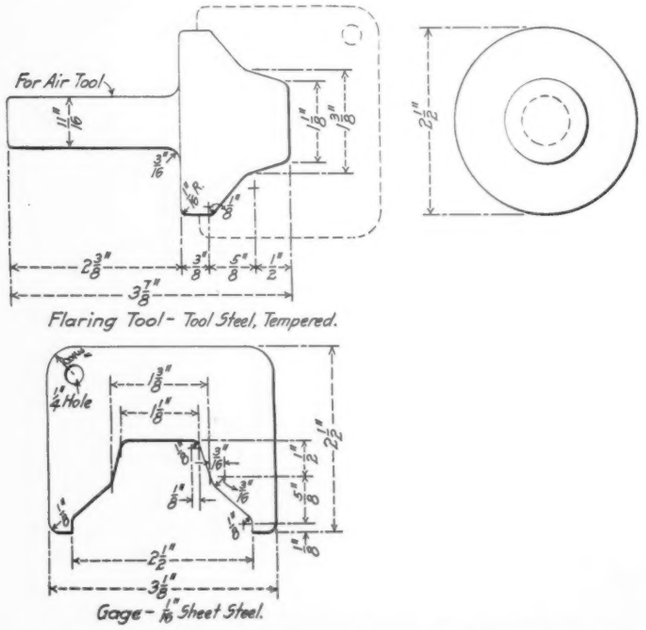


Fig. 12—Flue Flaring Tool, Used Preparatory to Prosser-Expanding.

ican Engineer. The same applies to copper ferrules. The tubes are ordered 1½ in. longer than the distance over the outside of the tube sheets, and are then cut so as to show ¼ in projection over each tube sheet for beading. The extra 1½ in. of length

For Stamping Number of Tool	Used With Expanders	A	B
M-1	S-1, S-2 P-1, P-2, P-3	3/8"	7/8"
M-2	S-3, S-4, S-5 P-4, P-5, P-6	9/16"	1 1/16"

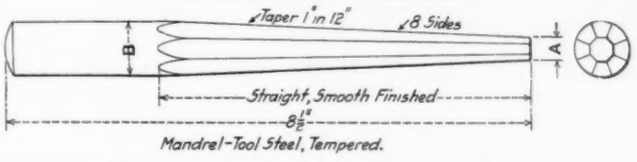


Fig. 15—Mandrel for Sectional Expanders.

will take care of any variation between the actual distance over the outside of the tube sheets and the distance shown on the drawings. The holes in the tube sheets must be carefully cleaned, and the ends of the tubes must have the scale removed

For Stamping Number of Tool	Tools used for Nominal Diam. of Tube	Diam. of Hole in Tube Sheet	A
R-1	2"	2 1/8"	1 13/16"
R-2	2 1/4"	2 3/8"	2 1/16"
R-3	2 1/2"	2 5/8"	2 5/16"

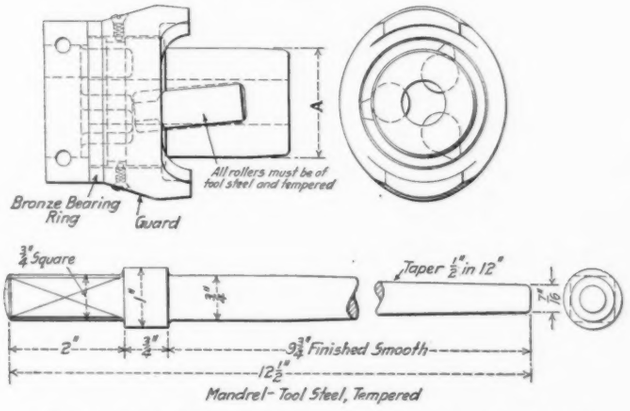


Fig. 16—Self-Feed Roller Expander for Tubes 2, 2¼ and 2½ In. in Diameter.

by filing before applying the tube. The copper ferrule should be set in the flue hole and seated with the sectional expander, Fig. 18. The tube should then be set in place, care being taken not to injure or misplace the ferrule; then the straight sectional

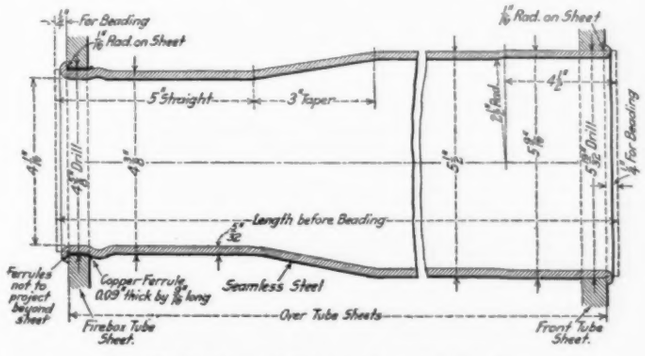


Fig. 17—Setting of 5½ In. Superheater Flues.

expander should be used to seat the tube against the copper ferrule. After this has been done the prosser-expander shown in Fig. 19 is to be used, and then the tube should be beaded over, using the beading tool shown in Fig. 21.

The operation for setting, expanding, beading and rolling for superheater tubes is the same as for boiler tubes, except that these tubes are beaded over on the front end. In removing superheater tubes the same process is gone through as with boiler tubes. Before prosser-expanding the tube, the end should

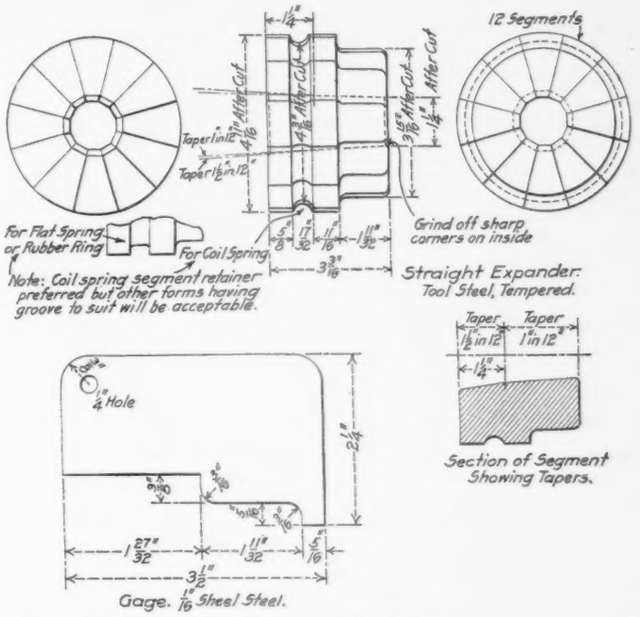

12 Segments
After Cut
Taper 1 in 12"
Taper 1 1/2" in 12"
For Flat Spring or Rubber Ring
For Coil Spring
Grind off sharp corners on inside
Note: Coil spring segment retainer preferred but other forms having groove to suit will be acceptable.
Straight Expander. Tool Steel, Tempered.
Taper 1/2" in 12"
Taper 1" in 12"
Section of Segment Showing Tapers.
1" 4 Hole
Gage. 1/16" Sheet Steel.

Fig. 18—Straight Sectional Expander for Copper Ferrules and Superheater Flues.

be flared to permit the prossering tool to enter to its proper depth. For hot work use the straight sectional expander for tightening the tubes in the back tube sheet; no roller expander should be used at this end. All superheater tubes in service should be re-prossered about once every 15 days, this being

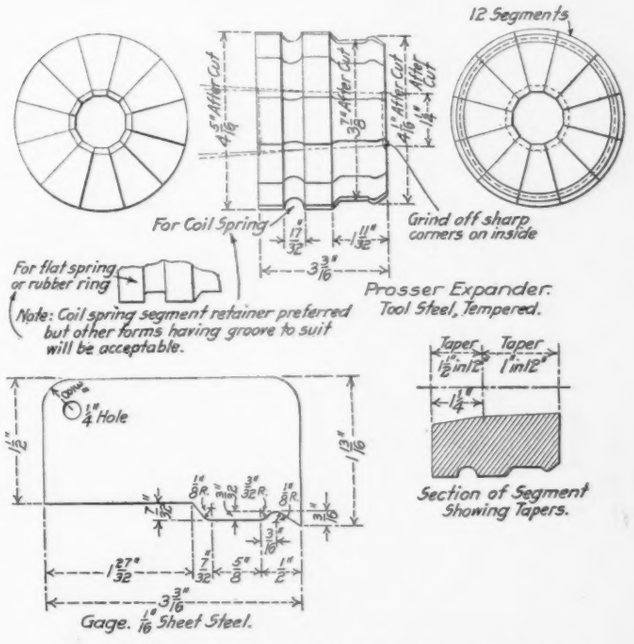

12 Segments
After Cut
For Coil Spring
Grind off sharp corners on inside
For flat spring or rubber ring
Note: Coil spring segment retainer preferred but other forms having groove to suit will be acceptable.
Prosser Expander. Tool Steel, Tempered.
Taper 1/2" in 12"
Taper 1" in 12"
Section of Segment Showing Tapers.
1" 4 Hole
Gage. 1/16" Sheet Steel.

Fig. 19—Prossering Expander for Superheater Flues.

regulated by the service. The front end of the tube must be tightened with the roller expander shown in Fig. 20, after which the end must be beaded over by using the beading tool, Fig. 21.

On account of the large size of the tube used it is possible to make the straight sectional expander for setting copper fer-

rules in the back end of superheater tubes in twelve segments. This gives a better distribution of the segments in the tube and a smaller working face against the tube, making the operation

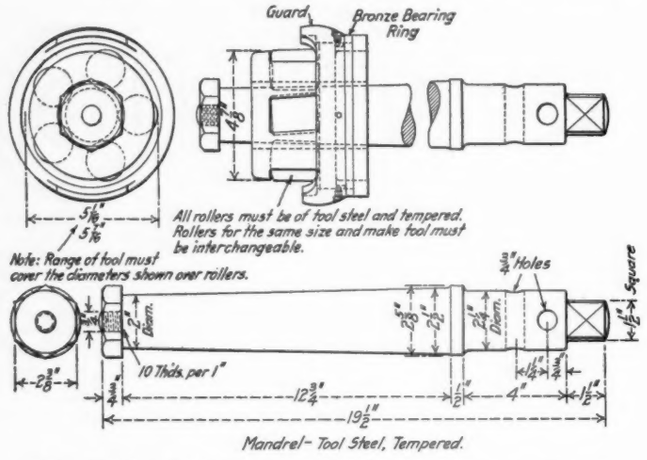

Guard
Bronze Bearing Ring
All rollers must be of tool steel and tempered. Rollers for the same size and make tool must be interchangeable.
Note: Range of tool must cover the diameters shown over rollers.
10 Thds. per 1"
Mandrel- Tool Steel, Tempered.

Fig. 20—Self-Feed Roller Expander for Superheater Flues.

much easier than if a large working face were provided. The prosser-expanding tool shown in Fig. 19 is also made in twelve segments. The beading tool for superheater tubes shown in

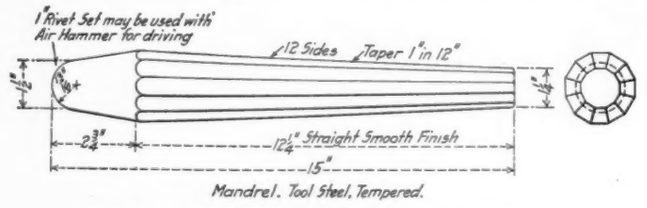

1" Rivet Set may be used with Air Hammer for driving
12 Sides
Taper 1" in 12"
12¼" Straight Smooth Finish
Mandrel. Tool Steel, Tempered.

Fig. 22—Mandrel for Large Sectional Expanders.

Fig. 21 is operated with a short stroke air hammer. The roller expander and mandrel for setting the front end of the tube, Fig. 20, is operated with an air machine. This tool is of the

A copper ferrule .09 in. thick, is used only at the flue sheet end of the arch tube; the opposite end bears directly against the door sheet. This has proved good practice, and very little trouble is experienced from leakage. Brass plugs are used for the holes

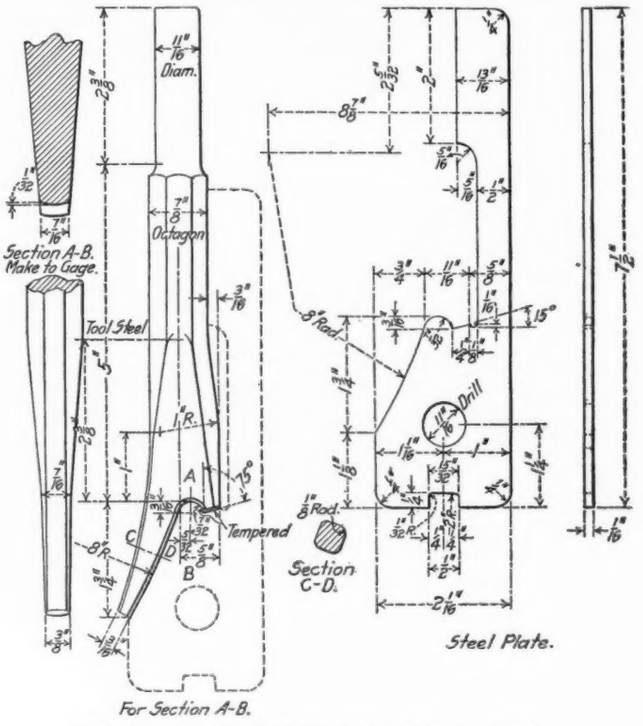


Fig. 21—Beading Tool for Tubes 5-32 In. Thick.

in the outside sheets opposite the arch tubes. These plugs are tapered ¾ in. in 12 in., and have 11½ threads per inch. Because of the thickness of this tube it is found desirable to bevel the inner edge to facilitate beading. At the throat sheet end of the tube a short radius is generally used to carry the tube

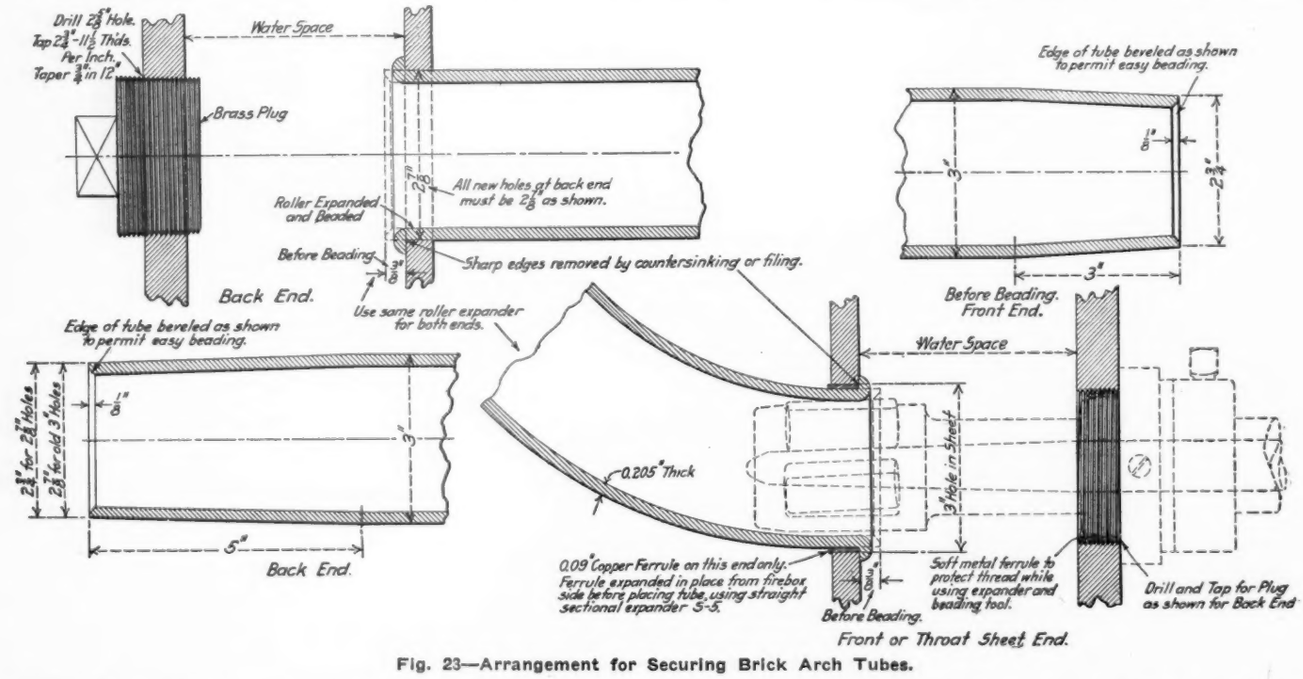

Drill 2⅝" Hole. Tap 2¾"-11½ Thds. Per Inch. Taper ¾" in 12"
Water Space
Brass Plug
All new holes at back end must be 2⅛" as shown.
Roller Expanded and Beaded
Before Beading
Sharp edges removed by countersinking or filing.
Back End.
Use same roller expander for both ends.
Edge of tube beveled as shown to permit easy beading.
Before Beading. Front End.
Edge of tube beveled as shown to permit easy beading.
Water Space
0.205" Thick
¾ Hole in Sheet
0.09" Copper Ferrule on this end only. Ferrule expanded in place from firebox side before placing tube, using straight sectional expander S-3.
Soft metal ferrule to protect thread while using expander and beading tool.
Drill and Tap for Plug as shown for Back End
Before Beading.
Back End.
Front or Throat Sheet End.

Fig. 23—Arrangement for Securing Brick Arch Tubes.

self-feed type. The mandrel used with the expanders shown in Figs. 18 and 19 is illustrated in Fig. 22, and is operated with a long stroke riveting hammer.

A proposed setting of brick arch tubes is shown in Fig. 23. away from the fire as quickly as possible. This is more desirable with a shallow depth firebox. Tubes are swaged down on both ends to permit using as small a hole as possible, and at the same time one size roller expander may be used for both

ends. In using the roller expanders a copper ferrule must be placed in the threaded plug hole in the outside sheet to prevent the threads from being injured by the expander guide.

The sectional expander for seating the copper ferrule in the flue sheet, which can be used only from the firebox side of the sheet, is shown in Fig. 24. As previously noted the mandrel shown in Fig. 15 is used with this expander.

A roller expander of the self-feed type, used for both ends

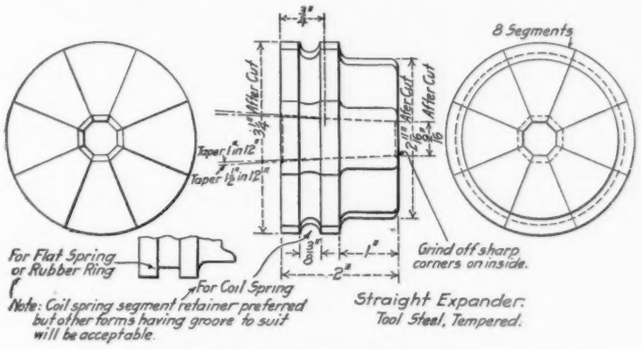

8 Segments
After Cut
Taper 1" in 12"
Taper 1½" in 12"
For Flat Spring or Rubber Ring
For Coil Spring
Note: Coil spring segment retainer preferred but other forms having groove to suit will be acceptable.
Grind off sharp corners on inside.
Straight Expander: Tool Steel, Tempered.

Fig. 24—Straight Sectional Expander for Brick Arch Tubes.

of arch tubes, is shown in. Fig. 25. With this tool it is sometimes necessary to have a short or "donkey" mandrel with a larger diameter at the small end to prevent the end of the mandrel from extending so far through the expander as to bear against tubes having a short radius. The beading tool used on both ends of the arch tubes is shown in Fig. 26.

Gages are provided for nearly all of the tools illustrated. This is to insure the tools being uniformly made. Gages are furnished to the manufacturers on application, but in connection

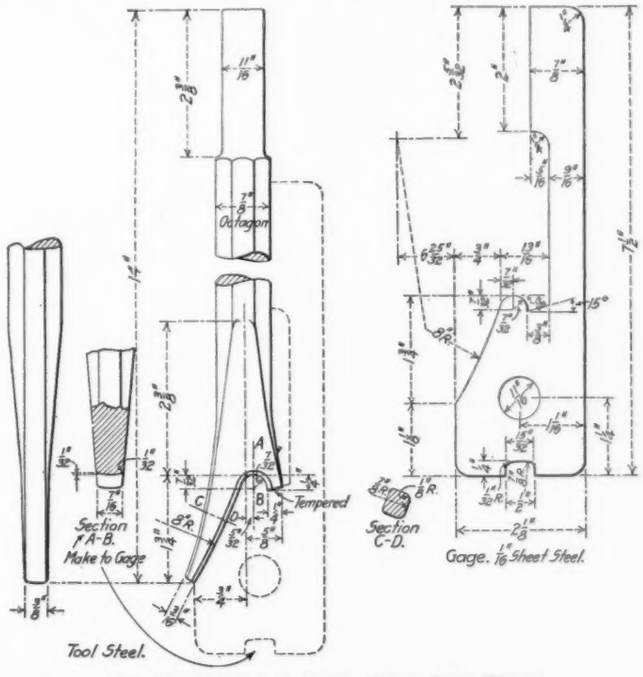


Fig. 26—Beading Tool for Brick Arch Tubes.

with this, it is absolutely necessary to have a master gage at the main shop of the railway, and all gages must be checked with this master gage before being loaned.

The tools should be kept in a general storehouse, and should not be distributed until inspected and passed upon by the engineer of tests, or some other designated inspector, as it is necessary that they be made absolutely to gage, and in accordance with the drawings.

Each tool is marked with a letter followed by a member. Thus letters F-1 to F-9 designate the ferrule setting tool; S-1 to S-10 the straight sectional expander; P-1 to P-7 the prossering expander; M-1 and M-2 mandrels, and R-1 to R-5 roller

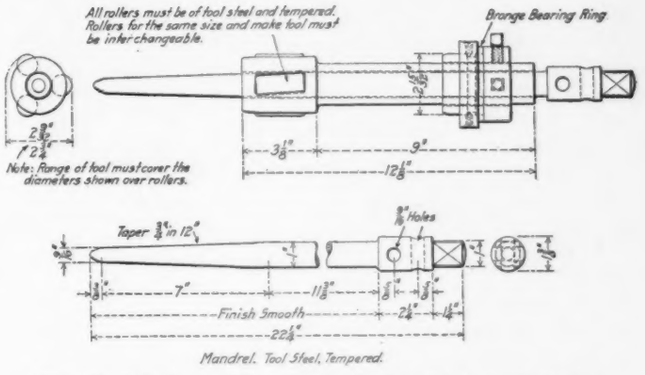

All rollers must be of tool steel and tempered. Rollers for the same size and make tool must be inter changeable.
Bronze Bearing Ring
Note: Range of tool must cover the diameters shown over rollers.
Taper ⅜" in 12"
⅜" Holes
Finish Smooth
Mandrel. Tool Steel, Tempered.

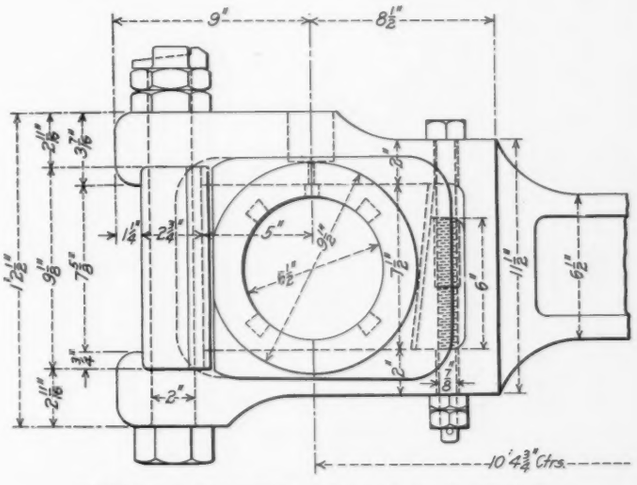
Fig. 25—Self-Feed Roller Expander for Brick Arch Tubes.

expanders. This is done so the shop men will become familiar with the different types of tools; and, when a tool is requested, the symbol given designates exactly the type desired.

REPAIRS TO MAIN RODS

By C. D. ASHMORE,
General Foreman, Chicago & North Western, Clinton, Ia.

In making repairs to the ordinary strap end main rod similar to the one shown in the illustration, it should first be completely dismantled and each part given a coat of whitewash and struck several heavy blows with a sledge to develop the presence of any cracks or flaws. If the parts are found to be in good condition and the brasses not sufficiently worn in the bore to make them useless, no new parts will be required except bolts. Most rods



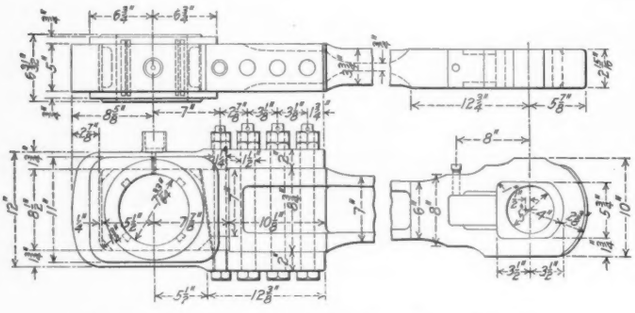
Forked End Main Rod; Chicago & North Western.

of this design will be found to have lost motion between the brass and the strap, and since the strap must have exactly parallel faces from the point of its attachment to the rod, the proper method is to bolt it in place and send it to the blacksmith shop. Here the back end is heated and closed to within the thickness of a piece of tin to the size at the point of connection with the rod. The reason for not bringing it to exact size is due to the shrinkage which will make it, when cool, almost the exact size required and it will only need a slight filing and cleaning to be ready for the brasses. When it is returned to the shop it should be removed from the rod and the ends spread

apart sufficiently to take out the spring and make an easy slip fit on the end of the rod.

The main brasses, meanwhile, should be taken to the shaper and closed to size for reboring for the crank pin fit. They then should be babbitted for lateral motion and in the strap fit and again taken to the shaper and planed for an easy fit in the straps. After the brasses are fitted, the strap should be put on the rod and held in a vise while the bolt holes are reamed. The best practice is to use a reamer driven by an air motor, the motor being supported by a cable which passes over a pulley to a counterweight. A high speed reamer should be used and the work can be done as quickly as on the drill press without the danger of breaking the reamer. The hole should be reamed to gage size and stock bolts used. The limit in increase of diameter of these holes is generally specified, one-quarter inch being a safe amount.

After the strap bolts are fitted, the strap should be taken from the rod and the brasses applied with one thickness of Russia iron between the two halves and the key should be driven down to hold them tightly in place. The strap and brasses should then be transferred to the boring mill and bored to a size larger than the caliper size of the pin by the thickness of a strip of Russia iron. After boring, the brasses should be separated and the thin liner between them removed, which makes the bore exactly right for the pin on the front and back centers and gives



Strap End Main Rod; Chicago & North Western.

a slight clearance at the top and bottom which allows for shrinkage when the brass cools in case it gets hot, and prevents it sticking on the pin. The brasses should be bored for a slip fit on the pin and no filing or scraping should be done. While on the boring mill the brass should also be faced. A side clearance of 1/32 in. is usually allowed.

In the case of the forked end rod of the general style shown in the illustration, the proper procedure is to remove sufficient material from the ends of the block to permit the fork being drawn together so that the inside faces can be made parallel by reslotting. The procedure for the brasses is the same as in the other style of rod and the re-reaming of the bolt hole and fitting of the new bolt is generally required. New brasses will not usually be required at the front end of the rod, and a special jig arranged to take any size brass and hold it for boring should be employed.

The time required and the cost of doing this work with the strap end rod, having three bolts, will be on an average about as follows:

	Time.	Cost.
Stripping back end of rod, machinist and helper	32 min.	$0.30
Closing brasses, babbitting and planing for strap fit	3 hrs.	1.35
Hand fitting brass to strap	30 min.	.19½
Close strap, reaming bolt holes, etc	6 hrs.	2.37
Fitting three new bolts	1 hr.	.20
Total cost		$4.61½

For the front end brasses the work can be done in about three hours' time at a cost of $1.25, or a total cost for two rods, not including cost of new bolts, of $11.33. If new brasses are required for both the back and front ends of the rod, the cost, including the material for brasses, which will weigh 150 lbs. for each pair of back end brasses and 53 lbs. for the front end brasses, will be $47.56.

In this connection some data recently collected at the Clinton shop on cost of repairs to main rods will be of interest. It was found that on the sixty-four engines passing through the shop for general and heavy repairs, 240 main rod bolts, 131 middle connection bolts and 17 side rod bolts were renewed, making a total of 388 bolts, or an average of 6 per engine. The total cost of these bolts at 21 cents apiece, which includes material and labor, was $129.68. During this time there were eight broken main rods which cost on an average of $100.00 apiece, 10 broken back end main rod straps which cost on an average of $14.79 apiece. Also during this time, 17 main rods were scrapped on account of the bolt holes being reamed to the limit, each of these costing on an average of $100.00, making a total of $2,987.58 for new bolts, main rods, broken straps and rods scrapped on account of bolt holes being too large. This is in addition to the cost for repairs.

CHART FOR FORGING MACHINE WORK

BY O. V. P. BULLEID*

The diagram on the opposite page has been found of great convenience in connection with forging work generally, and particularly in the design of the tools and the carrying out the work on forging machines. It permits a ready determination of the length of any sized round bar that will be required to give a certain length at any other diameter. It also gives the weight of the part for both wrought iron and steel. For example: It is desired to determine the increased length that should be given a 1½ in. diameter bar that is to be upset on the end to 2 in. diameter for a distance of 3 in. Using the diagram, it will be seen that a 2 in. diameter bar 3 in. in length is equivalent to a length of 5.7 in. on a 1½ in. diameter bar, showing that the stock should be cut 2 11/16 in. longer than the desired finished length of the piece after it is upset.

New Railway Mileage in Argentina.—During 1911 254 miles of new line were opened on the Buenos Aires Great Southern Railway. In the same year 313 miles of new line were opened on the Central Argentine Railway, and 221 miles on the Buenos Aires Western Railway.

Long Distance Flight.—The prize for the longest straightaway flight in France between sunrise and sunset was won by Pierre Daucort, a French aviator, on October 6. He made a flight of 570 miles in 11 hours and 39 minutes, stopping only three times to replenish the supply of fuel.

Interchangeable Axles.—According to the Portuguese *Gazeta de Caminhos de Ferro*, international slow freight traffic between Paris and Lisbon is now being carried in 15-ton covered trucks fitted with double sets of bearings, and the wheels and axles are changed at the frontier. This is effected by means of a pit sunk between the rails, the wagon being run on the trolleys, on separate tracks alongside the main line, while the narrow (or 4-ft. 8½-in.) gage wheels drop by gravity into the pit, and the wagon is run forward until it engages with the broad (or 5-ft. 6-in.) gage wheels. The whole operation (which is said to resemble that in force on the German-Russian frontier) only requires about 10 minutes, and the time required for the trip from Paris to Lisbon is reduced from 15 to 8 days. Ten of the wagons, which belong to a firm in Paris, and have been constructed in Germany, are now running, and an important saving is effected in freedom from loss and damage to goods. A special through rate has been arranged by the companies concerned.—*The Railway Gazette (London)*.

*Locomotive Department, Great Northern Railway, Doncaster, England.

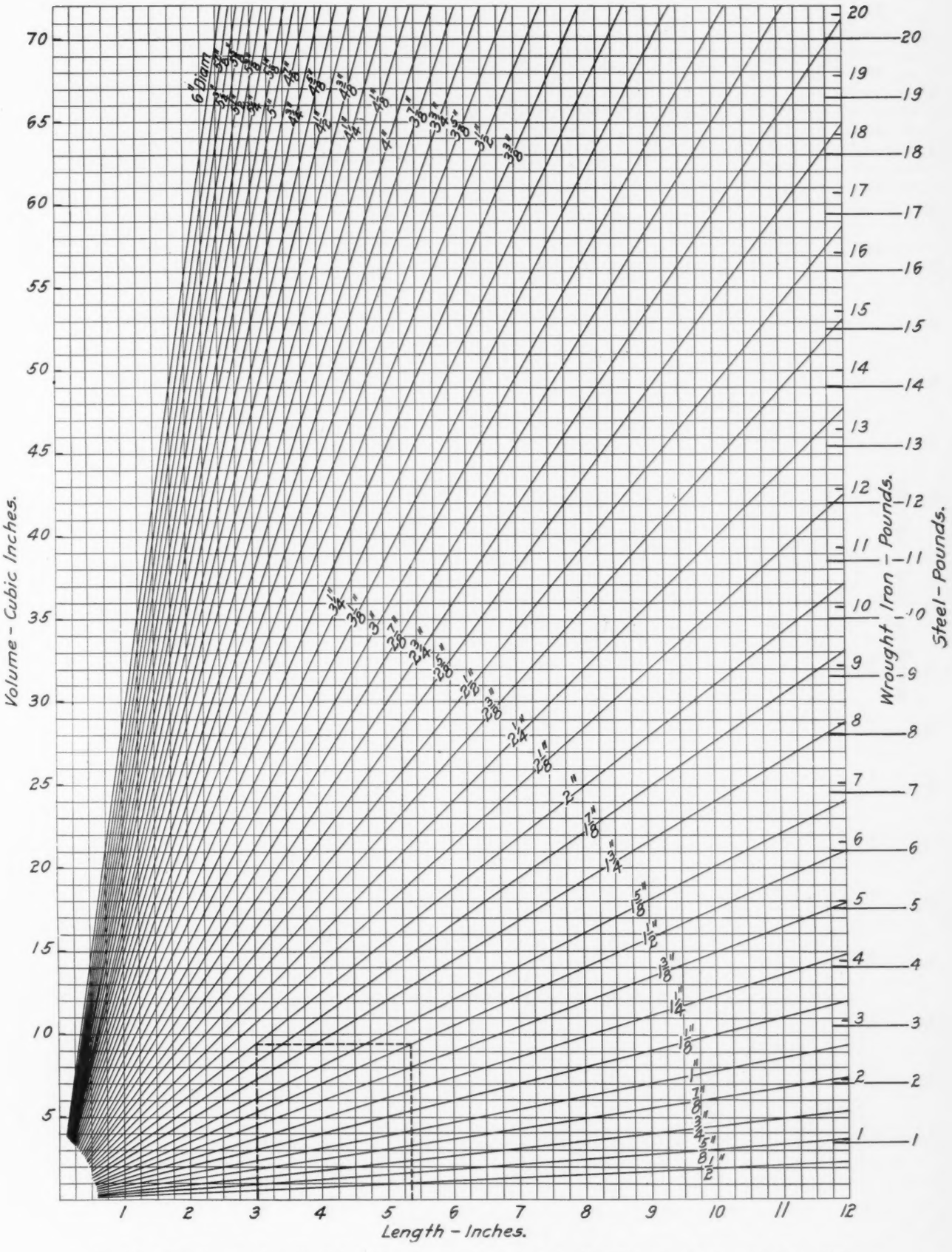
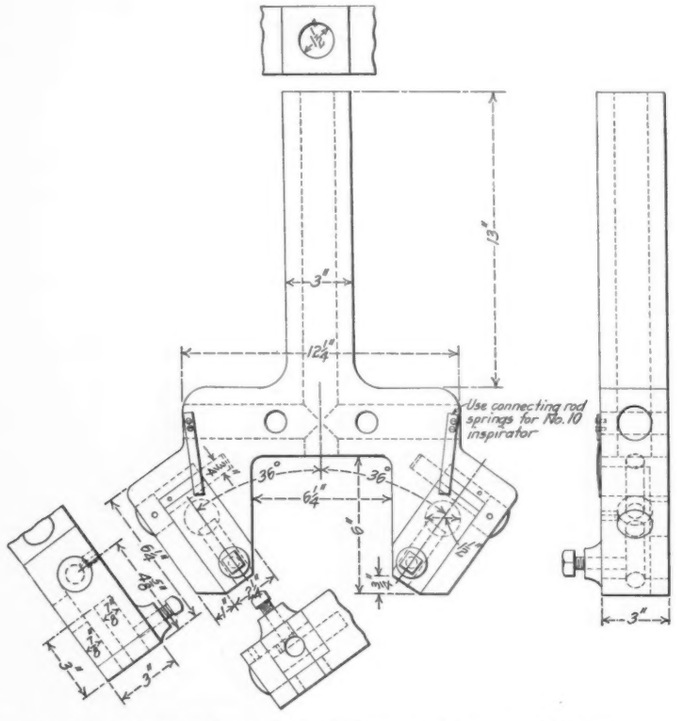


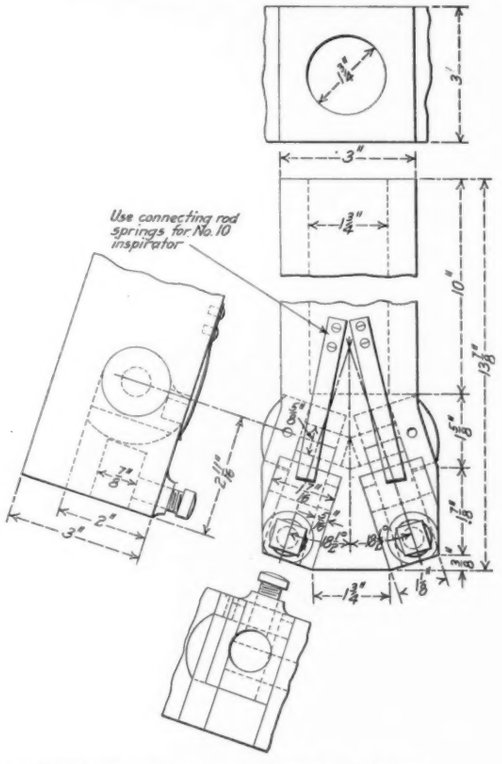
Chart for Equating the Length of Any Diameter Bar to that of Another Diameter Having the Same Volume.

PLANING SHOES AND WEDGES

Tools for planing the outside and inside of the flanges of shoes and wedges, designed by E. C. Smith at the Clifton Forge, Va., shop of the Chesapeake & Ohio, are shown in the accompanying illustrations. These tools have proved most efficient. The illustrations make the construction and arrangement clear and it will be seen that ample provision has been made for rigidity to take the maximum cut. The shoes and wedges are clamped, with the flanges up, to a long bar which has a width somewhat narrower than the shoes and is provided with slotted openings for the holding bolts. This bar is secured to the planer bed. The outside tool is then run down, finishing the outside of the flanges and the shoes or wedges are transferred to a chuck on the planer bed where the inside of the flanges are finished with the inside tool. Shoes and wedges are being machined at this shop for 14 cents apiece.



Tool for Finishing the Outside of the Flanges of Shoes and Wedges.



Tool for Finishing the Inside of Shoes and Wedges.

REPORT OF FEDERAL BOILER INSPECTOR

The first annual report of the chief inspector of locomotive boilers to the Interstate Commerce Commission for the fiscal year ending June 30, 1912, has just been received. A detailed report on the classified defects of 62,074 locomotives owned by 850 railroads and industrial plants and the number of accidents, together with the casualties, are included. Eight hundred and fifty-six boiler accidents are recorded, in which 91 persons were killed and 1,005 persons injured. The greatest number of accidents was reported from defective squirt hose and connections, there being 243 reported as injuring 245 persons. The next greatest number was from the breaking of water glasses, there being 165 of these accidents reported. They resulted in the killing of 1 person and the injuring of 168. The greatest number of persons killed was 35, caused by 69 crown sheet failures due to low water. These failures also injured 129 persons. There were 27 killed and 41 injured by 3 shell explosions.

A total of 173,321 defects was found on 48,768 locomotives from 74,234 inspections made on the 62,074 boilers, and 3,377 were ordered from service. The greatest number of defects was found in broken staybolts, there being 31,156 reported. The following gives the number of locomotives required to be strengthened or changed to comply with the requirements of the law or permanently removed from service for the respective reasons:

Pressure reduced to insure a proper factor of safety	699
Seams reinforced by welt plates to insure a proper factor of safety	327
Permanenely removed from service on account of defective condition	698
Lowest reading of water glass ordered raised to comply with the law	992
Lowest gage cock ordered raised to comply with the law	408
Strengthened by having braces of greater sectional area applied	351
Additional support for crown sheet	116

The report is signed by John F. Ensign, chief inspector of locomotive boilers.

Electric Railway Companies.—The total number of electric railway companies in the United States January 1, 1912, was 1,209. They operate on 41,028 miles of track, have 91,457 cars, and are capitalized at $3,267,960,542.—*Electric Railway Journal.*

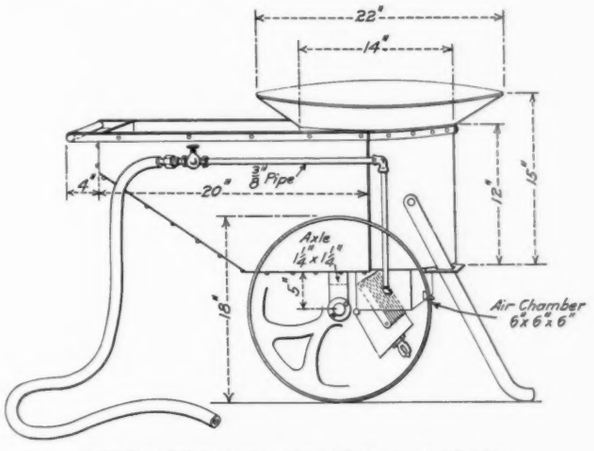
Rolling Stock on Victorian Railways.—In view of the rapid increases which are now being made in the Victorian Government Railways' rolling stock, it is interesting to note that in the past 10 years the increases were relatively small. While the train mileage increased by 17 per cent., and the gross earnings by 46 per cent. between June, 1901, and June, 1911, the number of locomotives in use was increased by only 14, and the number of passenger and freight cars by 3,000. The rolling stock on June 30, 1912, consisted of 612 broad and 11 narrow gage locomotives, 1,331 broad and 21 narrow gage passenger coaches, 634 broad and 2 narrow gage box, 14,097 broad and 195 narrow gage other freight cars of all classes and sizes, and 18 broad-gage cars for the St. Kilda-Brighton electric line. It should be mentioned, however, that during this 10-year period 144 old locomotives were broken up, and that the total tractive power of the locomotives in use in June, 1912, was 9,250,000 lbs., against 7,250,000 in 1910.—*Consular Report.*

CAR DEPARTMENT

PORTABLE RIVET FORGE

By F. H. BABCOCK.

While portable rivet forges are common, the one in use in the shops of the Pittsburgh & Lake Erie at McKees Rocks, Pa., is an improvement over most of the arrangements generally used. Reference to the illustration will show that this forge includes a box for the fuel and that it has a drop grate operated by the movement of the drop door at the bottom of the air chamber.



Portable Rivet Forge with Fuel Box Attached.

Both of these features assist in keeping the shop clean and make the work of the operator easier and the effectiveness of the forge greater. These forges, while cheap in construction, are substantial and will withstand hard usage. The barrel is lined with 2-in. firebrick which will last from six weeks to two months with ordinary care.

GRAIN CAR INSPECTION

By R. W. SCHULZE
General Foreman Car Department, Gulf, Colorado & Santa Fe, Cleburne, Texas.

During recent years much has been said and done towards improving conditions and lessening loss and damage claims due to grain shortage, and yet it appears as though these claims still exist and that the proper solution has not been reached. At many grain loading stations public scale weights are used, and in some cases the grain is loaded direct from the wagon into the car, while in others it passes through the elevator. Many farmers are very particular as to who they have drive their wagons on and off the scales. In a recent conversation with a retired farmer, he said that he had "sold his old darkey many a time on the end of the wagon tongue." These wagon weights are used as shipping weights and when a car reaches its destination it is not to be wondered at that the delivering weights sometimes show a shortage, which the shipper claims to be due to leaky cars.

It is possible, however, that sufficient attention is not given the selecting of cars for bulk grain loading. The agent, in many cases, has not the time and, in fact, does not inspect the cars to see what the true condition of the car is. He furnishes the shipper with a car number, which by chance is standing on his siding, and no attention is paid to the condition of the car. The shipper very often cares little as to the condition of the car he loads, and little assistance can be expected from some of them.

The inspection of grain cars has received a great deal of attention, and while it is the instruction of all railway managers to give them the very best attention possible, it is also understood that the only inspection that can be made of grain cars when loaded is an examination of the running gear, draft rigging and the general outside appearance of the car. The proper time to make an inspection is before the car is loaded. Under present conditions, as a rule, the only place where a thorough inspection can be made is at terminal points, where car inspectors are employed. Unless the railways employ car inspectors at their main grain loading stations this duty must necessarily fall to the agents, who as a rule understand very little of car construction and are not thorough and practical car men.

Even the most thorough inspectors will sometimes fail to discover a defect that will cause a small leak when the car is loaded and in motion. To overcome and repair such defects train crews should be instructed to look out for and report on their trip reports such leaks as may have developed on the line, as these cannot be located when the car is not in motion. Some of these small leaks are caused by grain working out through cracks in the siding or flooring or behind the grain strips. The lumber that is often furnished for siding and flooring is not thoroughly kiln dried, and therefore, shrinks more or less when applied to cars and the triangular grain strips do not in all cases fit up close to the siding.

The following practice should be required in grain car inspection, repairing and loading: All grain cars should be selected at terminals when possible to do so. These cars should be thoroughly inspected by a competent man, who, after making inspection, will attach to the side door of the car a grain inspection card, properly filled out and designating that car is fit for grain loading. The car must first be inspected for safety. The siding should be closely examined on the outside of the car, particularly behind the buffer block, and should be "hammer tested" for loose siding. The roof and side doors should also be closely examined from the exterior. The flooring should be carefully inspected and particular attention given to the condition over the center pins, around the draft bolt washers, and at the posts and braces. The lining and grain strips should be examined and close inspection given the grain strips to see that they are in proper place. The inside of the roof should be examined to ascertain if there are any signs of leaking. The side doors should then be closed to shut out the light and an inside inspection made, and if daylight can be seen the cracks or crevices should be repaired.

After the cars are placed for loading they should be properly coopered, using burlap strips over the joints between the door posts and the grain doors, and between the grain doors and the floor. After the coopering is done a joint inspection as to the condition of the interior of the car should be made by representatives of the shipper and of the railroad company. The record of this inspection should be made on a blank, especially prepared for this purpose and used as shippers' acceptance of the car. This would eliminate the claim of the shipper that an unfit car had been furnished, but would not bind him against a legal or just claim.

The present 2½ in. x 2½ in. triangular grain strip should be changed and made 2¾ in. x 3¾ in., and should be sawed with an obtuse angle of not less than 105 deg. This would keep the top of the grain strip against the siding, which would prevent the grain from working between the grain strip and siding.

All material used for flooring and siding should be thoroughly kiln dried and material partially dried should not be used.

Train crews should furnish trip reports covering all grain leaks,

the original report to be handed to inspectors on arrival at terminals.

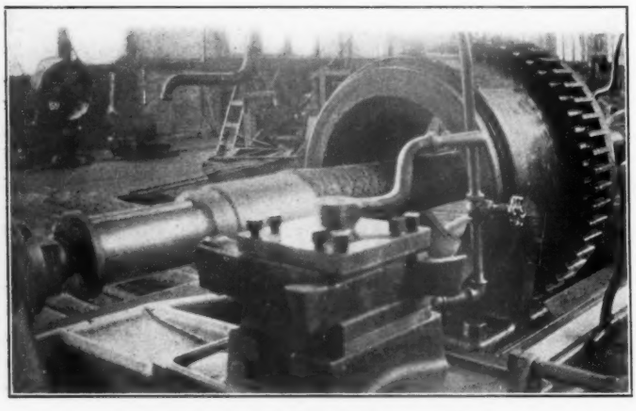
The traveling car repairers should be located at the principal grain loading stations during grain seasons; one man to look after two or three stations or more, as conditions will permit. The car repairer must keep a careful and accurate record of all cars inspected, their condition and what repairs if any were made before the car was given to the shipper. His report must indicate the general condition of the car, the condition of the siding, particularly behind the buffer block; condition of roof and side doors, flooring around draft bolts and center pins, and must show the date and station at which inspected. All of this information is necessary on each car, not only as a record, but also so that the general managers will realize that all cars are inspected by an expert inspector before they are carded by him and set for unloading.

The writer has had an opportunity to try such a method of grain car inspection during several grain seasons. The results from the beginning were gratifying. Shippers were satisfied, and records of cars inspected were kept in such shape that unjust claims could be investigated. The grain season was completed with many less claims for leaky cars than ever before.

INCREASING AXLE LATHE OUTPUT

By C. L. DICKERT
Assistant Master Mechanic, Central of Georgia, Macon, Ga.

A short time ago it became necessary to greatly increase the output of a car axle lathe in order to keep up with the regular repair work and in addition to provide the axles for one hundred new freight cars which were being built at the Macon shops. The work of turning new axles was performed in the customary manner, on a day work basis, and the lathe turned out nine new axles in nine hours. A careful study developed that six changes of tools were required in the finishing of each axle; in each case the tool had to be carefully set square with the work and it required the assistance of a helper and a

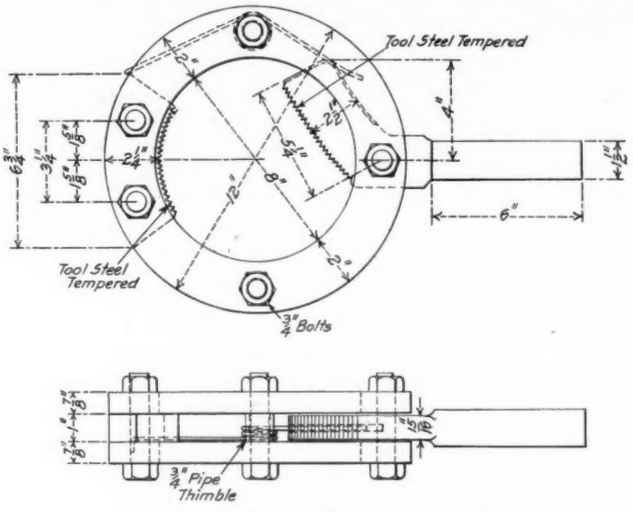


Axle Lathe Fitted with a Turret Tool Post.

long wrench to tighten it sufficiently to take the cut. Considerable time was also required in clamping the axle in the machine.

As a result of this study a turret type of tool holder which will hold four tools, three cutting tools and a roller, was designed so that the assistance of the helper was dispensed with and the output of the lathe was more than doubled. The machine is now turning out twenty new 4¼ in. x 8 in. axles in nine hours. The operator is still on the day work basis and it is very probable that if he was working on piece work, twenty-five new axles would be finished in nine hours, as an axle is often finished from floor to floor in twenty minutes.

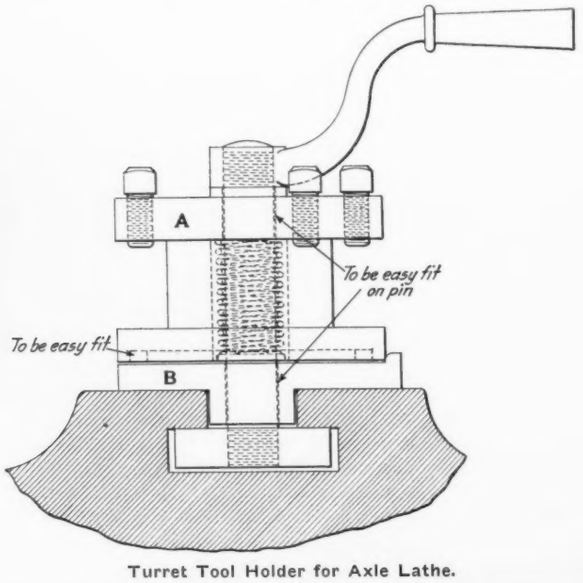
The tool holder is simple in its arrangement, and consists of a base plate properly shaped to fit in the carriage and held in place by a vertical shaft or pin which has a shoulder at the top of the base plate and screws into a block in the T slot. On top of the base plate is a ring about ⅜ in. high and ½ in. wide, concentric with the center pin. On one side of the base plate a lip ¼ in. in height is so placed as to center and brace the revolving head. This head has a groove to fit over the ring on the base plate and is arranged for carrying four tools, each of



Quick Acting Driver for Car Axle Lathe.

which has two set screws. A coil spring is fitted round the center pin and raises the revolving head when the clamp is released so that it can be swung clear of the shoulder on the base plate. With this arrangement the tools can be set with considerable less overhang than is required with the ordinary tool post and a much shorter tool is used. On a test it has been found that the tools will stand feeds and cuts that will stall the motor driving the lathe.

A quick adjusting driver was also designed which has reduced the time of chucking and removing the axle from the machine



Turret Tool Holder for Axle Lathe.

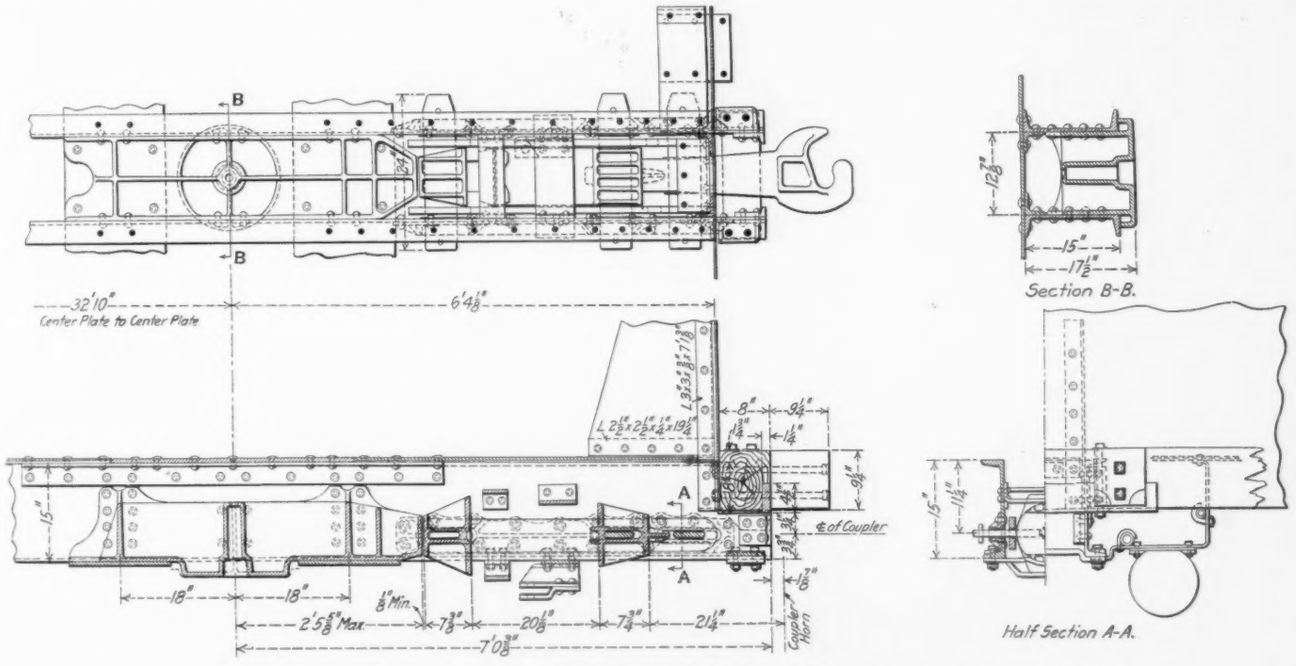
by three or four minutes. It is shown in one of the illustrations and all that is necessary is to slip it over the axle to the proper position; when the lathe is started it will automatically grip the axle. When the work is finished the driver is released in one motion and is slipped back on the overhang of the spindle. A spring is provided to hold the grip when the machine is running without load. Two drivers are necessary on the larger size axles.

NINETY-TON HIGH SIDE GONDOLA CAR

Developed on the Norfolk & Western and Equipped With Specially Designed Six-Wheel Equalized Trucks.

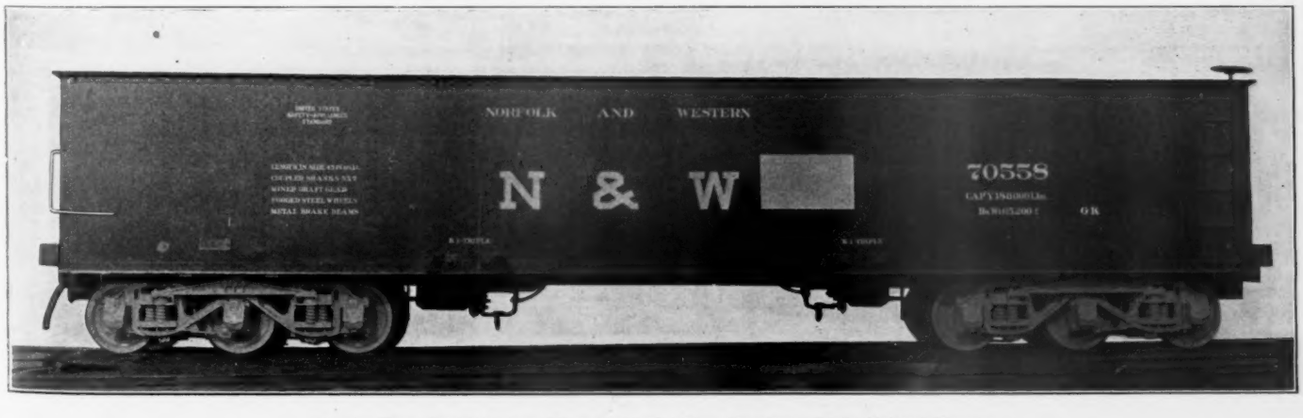
In view of the serious troubles that have occurred in the past with wheels and axles even under cars of 100,000 lbs. capacity when carrying the frequent large overload, it has seemed undesirable, except in a few special cases, to place cars of larger size on four-wheel trucks. A six-wheel truck must of necessity include some form of equalization, and heretofore has usually been considered to require a frame with pedestals in which the journal boxes have a free vertical movement. That type of truck is not well suited for freight service, and in designing a car of 99 tons maximum capacity on the Norfolk & Western, an entirely new six-wheel truck has been developed. It permits the use of the ordinary 5½ in. x 10 in. M. C. B. journal box rigidly secured to cast steel side frames which are so arranged as to act as equalizers without the application of extra parts. If this truck proves to be all that is expected, an opportunity will be given for the operation of cars on those lines handling large amounts of coal and ore that will give a considerable increase in the percentage of revenue load in a train.

These cars are of the high side gondola type and measure 9 ft. 6 in. in width, 6 ft. 6½ in. in height and 45 ft. 6¼ in. in length on the inside of the body. This gives a cubic capacity of 2,829 cu. ft. level full, and 551 cu. ft. in a 30 deg. heap, making a total of 3,380 cu. ft. Pocahontas run of mine coal is taken at 58.85 pounds to the cubic foot. The first load of coal hauled in the car was 95 tons, with some corners not quite filled out. The maximum outside dimensions are 48 ft. 4⅞ in. over bumping blocks, 10 ft. 4½ in. to the top of the side of the light car, 11 ft. 1 in. to the top of the brake shaft and 10 ft. 4½ in. extreme width over the body. The cars are provided with eight small drop doors in the floor, which are operated by a simple type of winding chain and shaft mechanism. The design is of the continuous center sill type. Cross beams or diaphragms are in-

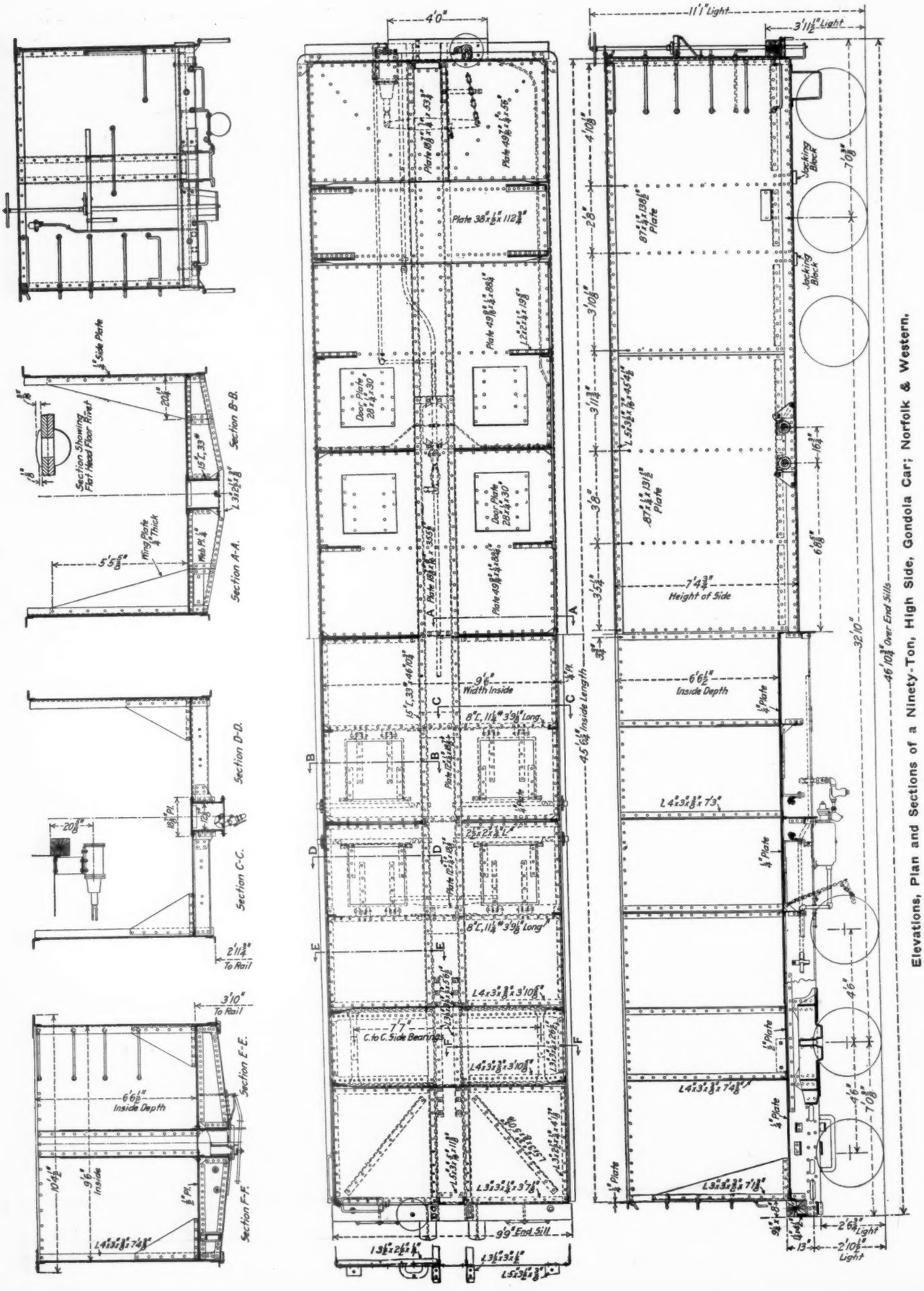


This drawing shows the construction for a Farlow-Sessions draft gear. A Miner draft gear is used on the car.

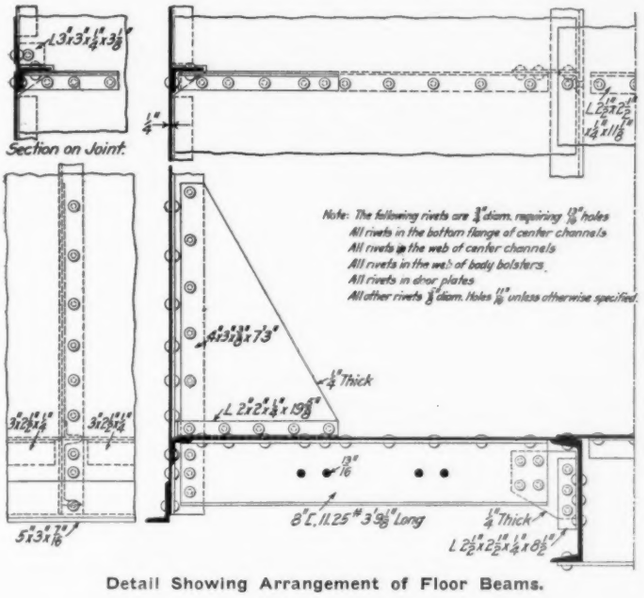
Arrangement of Draft Gear on 90-Ton Gondola Car; Norfolk & Western.



Ninety-Ton Gondola Car Mounted on a New Design of Six-Wheel Truck.


Section B-B.
Section A-A.
Section D-D.
Section C-C.
Section E-E.
Section F-F.
Section Showing Flat Head Floor Rivet
Wing Plate ⅜ Thick
Side Plate
To Rail
Inside Depth
Inside
Width Inside
Inside Length
Height of Side
Inside Depth
C. to C. Side Bearings
End Sill
Over End Sills
Light
Jacking Block
Plate
Door Plate
Elevations, Plan and Sections of a Ninety-Ton, High Side, Gondola Car; Norfolk & Western.

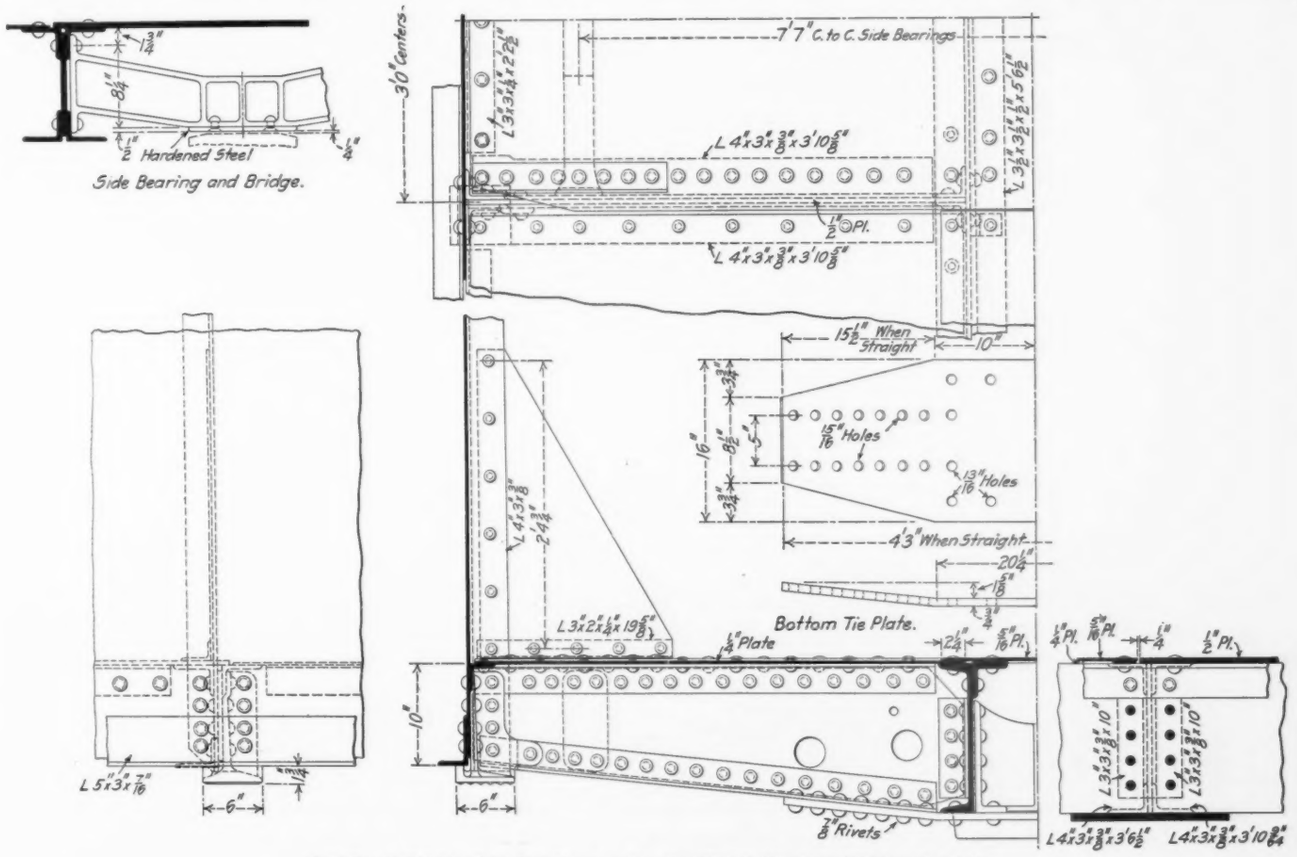
troduced to prevent deflection of the center sills, which, in a car of this length, would prove serious. This results in transmitting the load to the sides of the car which carry it, as plate girders,


Section on Joint.
Note: The following rivets are ¾" diam. requiring 13/16" holes
All rivets in the bottom flange of center channels
All rivets in the web of center channels
All rivets in the web of body bolsters.
All rivets in door plates
All other rivets ¾" diam. Holes 13/16" unless otherwise specified.
¼" Thick
8" C. 11.25 # 3'9⅛" Long
¼" Thick

Detail Showing Arrangement of Floor Beams.

to the bolsters, whence it is transferred to the center plates. The stakes are on the inside and while interfering to a limited extent with lading other than coal, ore, or similar material, have a number of advantages. With outside stakes, the punching of the upper flange of the side of the car for rivets detracts materially from the strength of the section, this portion being in tension; while with inside stakes the rivet holes are on the compression side of the member. It has also been possible, with inside stakes, to do away with body cross ties, which are undesirable and form a fertile source of repair bills. Inside stakes are of particular advantage in this case, inasmuch as they form the means of powerful side stiffeners near the top chord angle of the side plates. As this car was designed for use in a dumping machine, it will be seen that such construction is necessary.

Commercial shapes are largely used, special castings being incorporated at a few points only. The center sill consists of two 15 in. 33 lb. channels which are continuous for the full length over end sills. These are set 12⅞ in. apart with the flanges extending outward and a 5/16 in. top cover plate extends continuous between the bolsters. The edges of the ¼ in. floor plates extend under this cover plate and are secured to the center sills by the same rivets. At the double body bolster there is a ½ in. plate 38 in. in width, and extending across the car, which forms the floor at this point. Between this and the end of the car the center sill cover plate is ¼ in. thick. At the bolster the center sill is reinforced at the top by 3½ in. x 3½ in. x ½ in. angles arranged as shown in the illustration. The three cross bearers each consist of a 3 in. x 2½ in. x ⅜ in. angle continuous under the center sill and secured to the bottom of the side posts at either end. They also include a ¼ in. web plate on either side between the center sill and side. This plate is made in two parts, the outer end for a distance of 20¼ in. consisting of an extension on the wing or gusset plate which is carried nearly to the top of the sides. The remainder is a properly shaped plate which extends only to the floor. The joint between the two is made with a splice plate ¼ in. thick. The top member of the cross bearer consists of two 2½ in. x 2 in. x ¼ in. angles extending



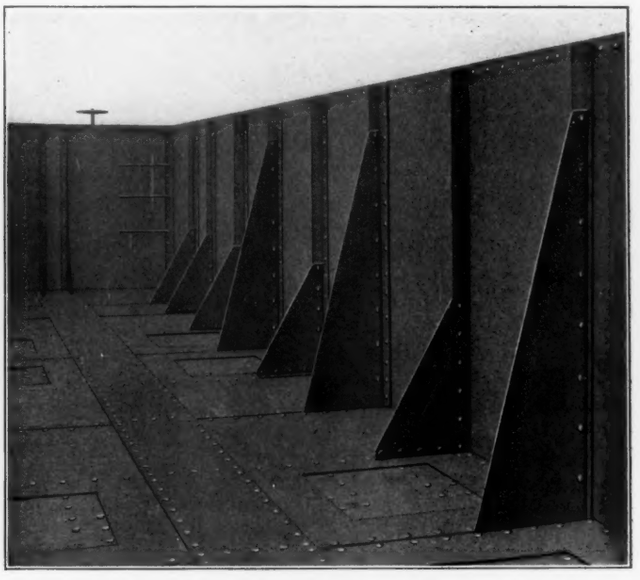
Details of Bolster Construction on the Norfolk & Western 90-Ton Gondola.

between the center sill and the side plate. The floor plates are of such a size that the joints come at the cross bearers and the edges are riveted to the angles.

Midway between the cross bearers and also between them and

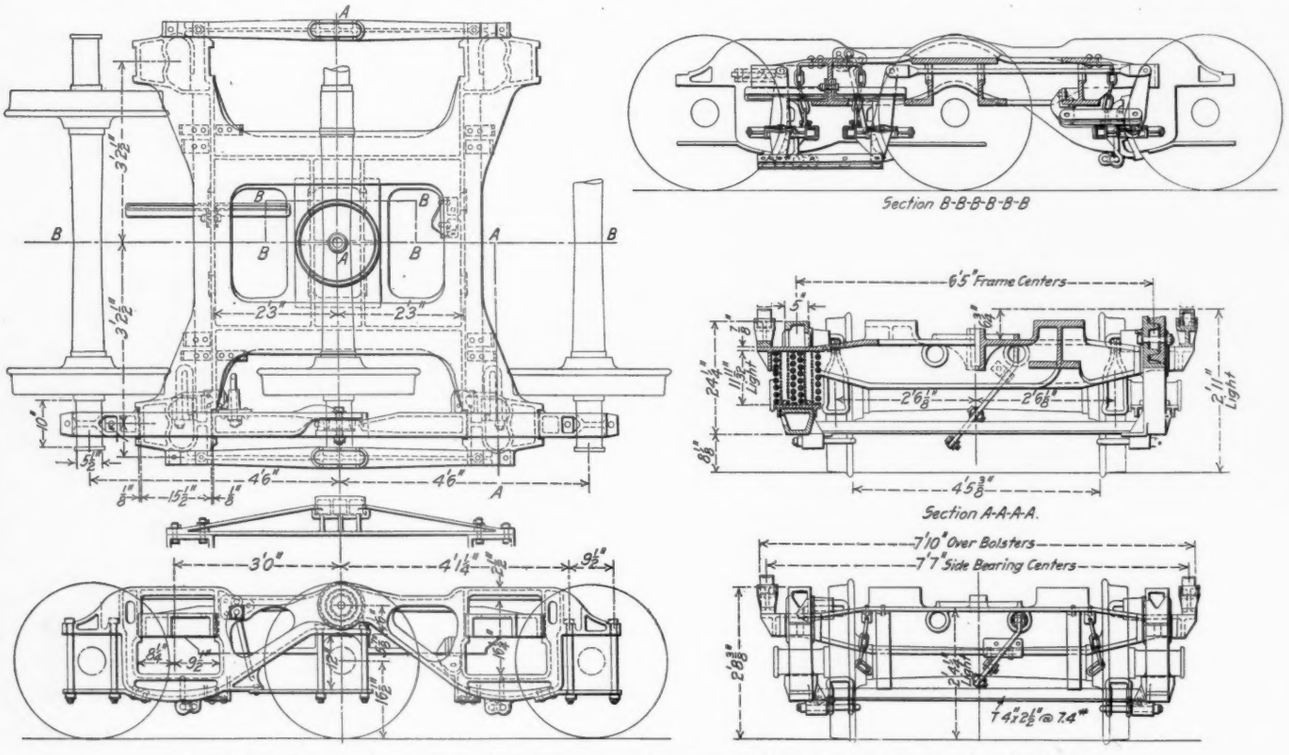
the bolsters are floor beams, consisting of 8 in. 11¼ lb. channels with the outer ends riveted to the bottom of the side posts and the inner ends secured to the center sills through the medium of ¼ in. gusset plates and angles fastened on the webs of the center sill channels. The smaller wing or gusset plates are located above these floor beams and consist of triangular ¼ in. plates about 28 in. wide at the bottom and about 31 in. high riveted to the side posts and secured on top of the floor plates by angles of the proper length, the rivets holding the angles also extending through the flanges of the channels which form the floor beams. At both the floor beams and cross bearers there is a short reinforcing angle riveted to the top cover plate of the center sill, which is also the floor plate.

In view of the large weight concentrated at the center plate it was necessary to design a bolster of unusual strength and rigidity which would properly convey the load from the side girders, which carry the greater portion of it. Practically two bolsters, set 36 in. apart, have been employed and a large casting fitted between the center sill channels connects the two and includes the center plate. Each of these bolsters consists of a ½ in. web plate and a pair of 4 in. x 3 in. x ⅜ in. angles at the top. Similar angles at the bottom, which in both cases extend only from the side plate to the flange of the center sill channel, are also used. A ¾ in. plate, 16 in. in width at the center and tapering to a width of 8½ in., extends under the center sill and the center plate casting and is riveted on either side to the flanges of the bottom angles. At the junction of the side plate and each of the bolsters there is a jacking casting, formed to fit around the bottom end of the side post and strengthen the construction at this point. This gives four jacking points at each end of the car. A ½ in. top cover plate of sufficient width to include both parts of the double bolster extends across the car and is secured to the side plate by an angle. The side bearings are attached to



Interior of the 90-Ton Gondola Car.

in length. The vertical joints between these sheets are made by ¼ in. splice plates on the inside, and the double stakes at these points are set in enough to allow for them. This plate girder, of which the side plates form the web, has a 5 in. x 3 in. x 7/16 in. angle at the bottom with the flange extending outward, and a 5 in. x 3½ in. x 7/16 in. angle at the top. Both angles are continuous for the full length of the car. There are no diagonal braces and the plate is stiffened by the 4 in. x 3 in. x ⅜ in.

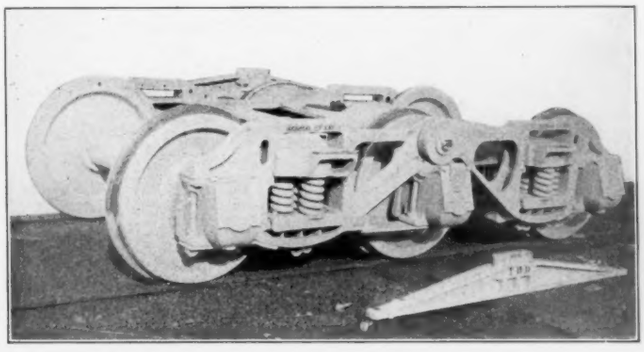


Six-Wheel Equalized Truck with Journal Boxes Secured to the Side Frames; Norfolk & Western.

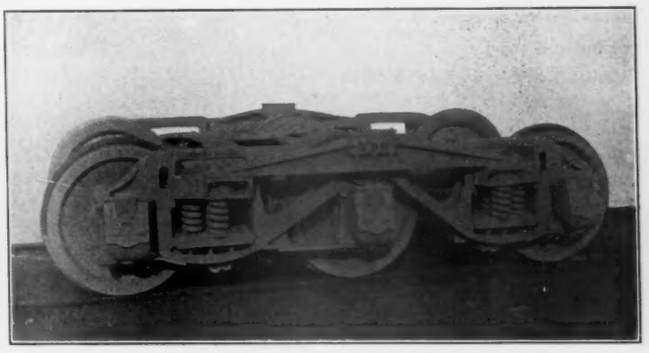
a properly shaped casting forming a bridge between the two bolsters and are located at a radius of 3 ft. 9½ in. from the truck center.

A large proportion of the load is carried by the sides of the car which consist of ¼ in. steel plates 87 in. in width and 138 in. angles forming the stakes, which are spaced as shown on the drawings. These angles continue to the bottom of the side plate and are fastened to the cross bearers and floor beams. As before mentioned the wings or gussets of two different sizes form the principal source of stiffness for these girders.

The construction at the end is practically the same as at the sides. The corner posts, however, are 3½ in. x 3½ in. x ⅜ in. angles. The end sill is of oak 8 in. x 9¼ in. and the center sill channels are cut out at the top sufficient to allow its introduction. The end sheet of the car extends behind the end sill which is also reinforced by the end posts and the angle to which the floor plates are secured.

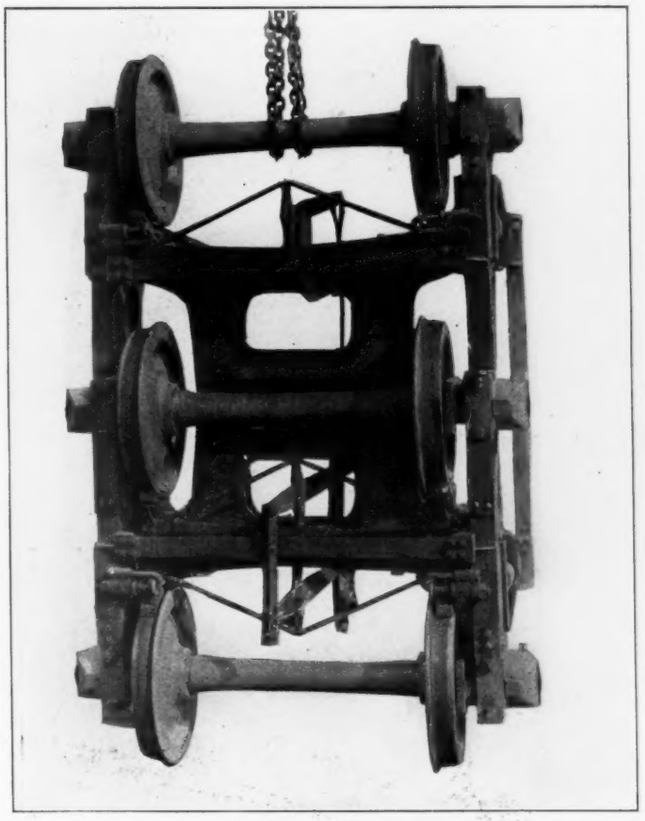


Truck with Side Bearing Bridge Removed to Show the Hinge Joint.

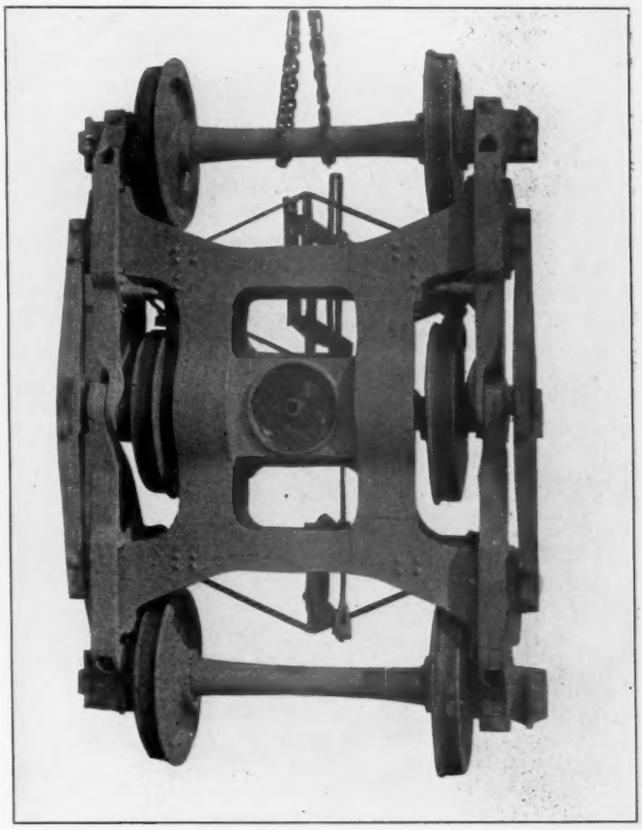


Side View of the Six-Wheel Truck Complete.

The car has a Miner friction draft gear with Miner attachments. It will be seen that the gear is attached directly to the center sills with the usual reinforcing castings on the webs and that the coupler yoke passes below the wooden end sill, the carrier iron being bolted to the bottom flanges of the center sills. The rear casting of the draft gear has a minimum clearance of ⅛ in. from the extension on the center plate casting. The center of the line of draft is 3¾ in. above the bottom of the center sill channels.



Under Side of the New Six-Wheel Freight Car Truck.



Top View of the New Six-Wheel Freight Car Truck.

Each car has two sets of brake rigging, including auxiliary reservoirs, triple valve, brake cylinder, etc. The reservoirs are supported below the center sills just inside of the truck and the train line passes between the two center sill channels for the distance between the bolsters. At the bolsters and to the end of the car it runs outside of the sills. The brake cylinders are located just under the end sill, there being one at either end of the car connected to the adjacent triple valve and reservoir. The hand brake is located on the opposite side of the car from this cylinder and connects to the opposite end of the same brake lever. This location of the brake cylinder is somewhat in the nature of an experiment and arrangements have been made for placing the cylinders between the trucks at about the usual locations if the present location should prove unsatisfactory.

A six wheel equalized truck without pedestals is a novelty and has been developed for use on this car by W. H. Lewis, superintendent of motive power and John L. Pilcher, mechanical engineer. It consists of a cast steel side frame in two parts and of peculiar shape arranged to carry three journal boxes at 4 ft. 6 in. centers. Directly above one of the journal boxes the cast-

ings are arranged for a swivel connection. In these two castings the openings for the ends of the bolster and for the group of coil springs are spaced at 3 ft. centers from the center axle, bringing them 18 in. from the outer axles. One of the illustrations clearly shows the form and arrangement of the double cast steel bolster which carries the center plate. This rests on four nests of three double coiled springs each and has an extension beyond the side frame to allow the attachment of a bridge which carries the side bearing at the center of the truck. This bridge is bolted to the bolster extensions. Each group of springs consists of three nests of an outside coil of 1¼ in. diameter wire, 5 in. outside diameter, with an inside coil of 9/16 in. wire, 2¼ in. outside diameter. The springs work at 40,000 lbs. stress in the bar when the car is loaded to a 10 per cent. overload. The free height is 11½ in. with a total deflection, free to solid, of 1¾ in. The swivel joint in the side frame is so formed as not to give any shearing action on the bolt. This arrangement is shown in the sectional view through the center of the truck. This view also shows that the bolster is not as heavy as it might appear in the photograph. There are two 4 in. x 2½ in. tees bolted to suitably formed lugs on the bottom of the side frames and located midway between each of the pairs of wheels. These take the place of sand planks which are not feasible when the bolsters are arranged in respect to the wheels as they are in this case. It is possible that these cross ties may be omitted altogether. Tests will be made to determine this.

The brake rigging on each truck is comparatively simple and arranged in a manner similar to a six-wheel passenger truck. Designs for carrying the brake beams from either the side frame or the bolsters have been prepared. The one given here shows the former. This truck has been patented by Messrs. Lewis and Pilcher.

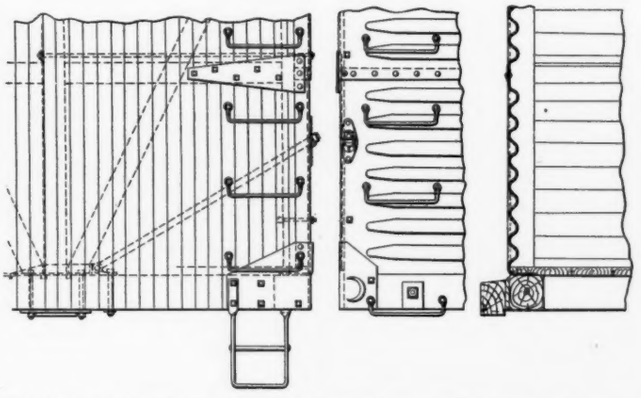
The weight of the two trucks alone is 29,800 lbs., and of the car complete with trucks is 65,200 lbs., giving a total weight with lading, including a 10 per cent. overload, of 263,600 lbs., or an average weight per axle at the rail of slightly less than 44,000 lbs. With a 10 per cent. overload the proportion of revenue lading to total weight will be about 75 per cent., and it will be over 73 per cent. without the overload. It is expected that it will be possible to reduce the weight slightly, especially that of the trucks in later cars.

The entire car has been carefully designed with a view to ease of manufacture. To this end all plates and shapes are laid out for multiple punches, and care has been taken that if the plates, etc., come within the customary variations in shearing, no reshearing will be necessary. Duplication of parts has been carefully considered with good results.

A STRONG BOX CAR END

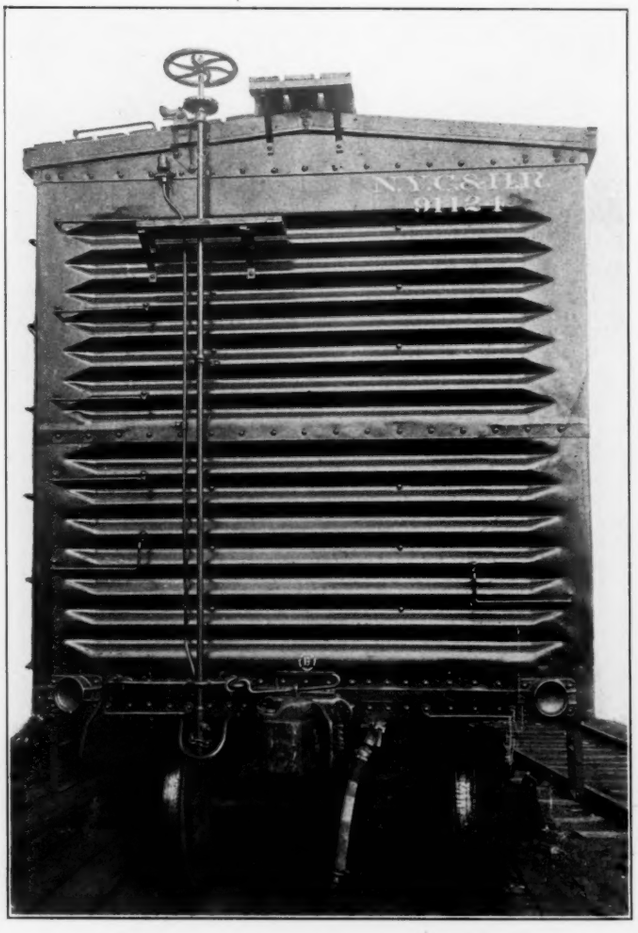
The New York Central & Hudson River is applying a steel end to many of its old box cars and expects to specify it on new equipment. Ordinary box car construction develops marked weaknesses at two points—the draft sills and the ends of the car. In repairing and increasing the capacity of some of its older box cars the New York Central has found it advisable to apply steel underframes. This remedied the difficulty with the draft sills and it then became desirable to overcome the next most important weakness—the ends. This was accomplished by the development of a steel end, as shown in the illustrations, and several hundred cars are now equipped with it. The New York Central Lines west of Buffalo have also applied it in considerable numbers.

The most important advantages are that the greater strength of the steel end prevents damage due to the shifting of the lading and thus reduces the cost of repairs and of damage to the lading, and of the time out of service because of such damage. The steel construction is lighter than that of wood; the old style wooden end on a certain class of New York Central cars weighed 1,863 lbs.; a better design of reinforced wooden end weighed 1,790 lbs.; and the steel end for the same class of car weighs 1,607 lbs. No end posts are used with the steel end



Details of Application of Steel End to New York Central Box Cars.

and the inside length of the car is thus increased by about one foot, with a corresponding increase in the cubical contents of the car. There is no possibility of the ends becoming loose and thus allowing grain or similar lading to leak out, as is so often the case with the wooden construction. If the end is seriously

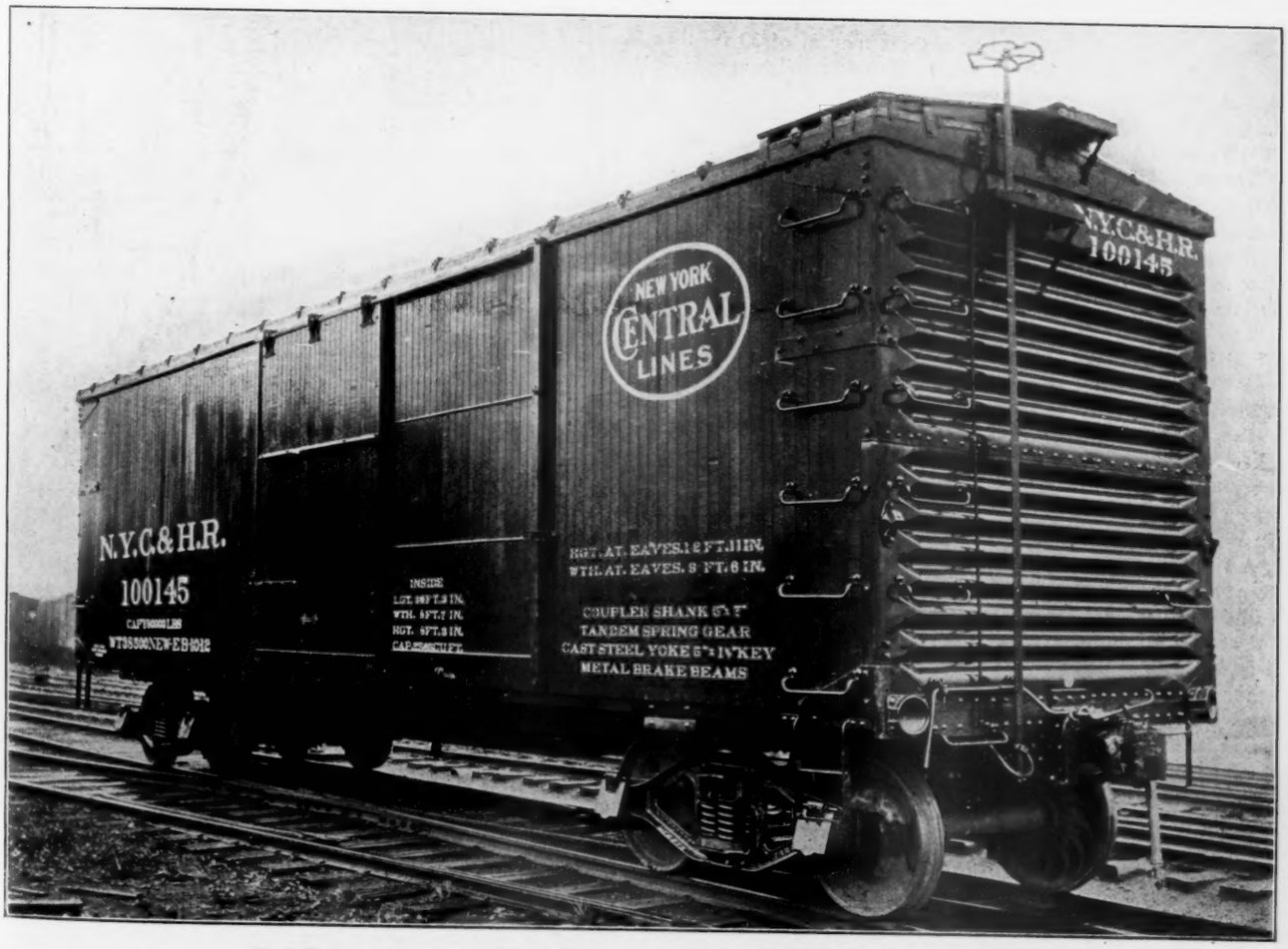


Steel End As Applied to New York Central Box Cars.

damaged it has a considerable value as scrap, while the wooden end is valueless.

The end is made in two parts to facilitate erection on the rip tracks or where an overhead crane is not available. If desirable

Steel End Applied to Experimental Steel Box Car; New York Central & Hudson River.



Steel End Applied to 40-Ton Wooden Box Car; New York Central & Hudson River.

the two parts may be riveted together in advance if it is desired to apply them at shops where there is a good crane service. The two-part end has the additional advantage of reduced expense for replacement if one-half should be seriously damaged and need renewal. Since the lower half of the end is usually subjected to the greater punishment due to shifting loads it is made slightly heavier than the upper half, being ¼ in. thick, as compared to 3/16 in. for the upper half. The reduction in thickness of the upper half is estimated to save about 300 lbs. in the weight of the car. The lower half of the end is said to be equivalent in strength to a flat steel plate ⅞ in. in thickness.

One of the illustrations shows the application of the end to a wooden box car, while another shows it applied to the all-steel box car which is being experimented with on the New York Central. When applied to a wooden car, the lower edge of the end is flanged and fits under the floor plank, effectually preventing any possibility of leakage of grain at the end. The manner in which the end is tied by a 1½ in. rod to the combination casting which forms a pocket for the foot of the post and braces is also shown on the drawing. The door is manufactured by the Imperial Appliance Company, Chicago.

FREIGHT CAR TRUCK EXPERIMENTS*

About the middle of the year 1910 the American Steel Foundries reported the results of a series of tests on square and loose freight car trucks made by Professor Endsley of Purdue University at the company's plant at Granite City, Ill. These tests were described in the *American Engineer and Railroad Journal* of May, 1911, page 192, and while they presented interesting data it was shown that further tests on tracks of different characteristics would add greatly to its value. The first set of tests was made on a special track consisting of a sharp incline, having a drop of about 36 ft., followed by a short tangent of 30 ft., then by a 22 deg. curve 303.3 ft. in length, the outer rail being raised 4½ in., followed by another tangent of 257 ft. and ending in an incline with a vertical rise of 20 ft. The curve had a rise of 3 ft. 10¾ in. in its length and the tangent following of 11.73 feet.

The second set of tests was conducted during the summer and fall of 1911 at the Granite City plant by Professor Endsley. Six tracks were used in the tests as follows:

A tangent 591 ft. long, running out from the incline having a drop of 36 ft. At the outer end of this track there was another incline.

Two tracks of 3 deg. curvature and 450 ft. long with a tangent of 28 ft. at both ends of each track. One track was laid with new 75 lb. rails and had a radius of 1,910 ft.; the other with badly worn old 75 lb. rails having a radius of 1,910 ft. 5⅜ in.

Two tracks of 6 deg. curvature and 420 ft. long with a tangent of 25 ft. at one end of each track and 178 ft. at the other. These were laid as above with new and old 75 lb. rails; the new rails had a radius of 954 ft. 9⅝ in. and the old ones a radius of 955 ft. 3 in.

A track of 12 deg. curvature, 250 ft. long, with a tangent of 25 ft. at the outer end and 330 ft. at the inner end. This track was laid with 75 lb. new rails and had a radius of 478 ft.

The gage of the tangent, the 3 deg., and the 6 deg. tracks was 4 ft. 8½ in. and that of the 12 deg. track was 4 ft. 9 in.

TRUCKS TESTED.

The tests were conducted on an arch bar truck and an Andrews side frame truck. The arch bar truck conformed closely to standard practice in its design and details of construction, and was the same as truck *B* used in the previous tests, weighing 22,886 lbs.

The Andrews side frame truck was of standard design with the exception of a heavier cast-steel bolster which brought the weight of the truck, with 650 lbs. wheels, up to 12,034 lbs., which, with the cast-steel block gave a total weight of 22,400 lbs. A 13-in. channel was used as a spring plank and was fastened to each side frame by eight tapered bolts instead of being riveted, as is customary. The truck was tested both with and without these bolts. When the bolts were removed, the side frames were spaced apart the proper transverse distance by a boss on each end of the spring plank, which fitted into recesses drilled in the center of the spring seat of each side frame. These two conditions are called the square and loose trucks.

TRUCK WHEELS.

Thirty-two different wheels were used in such combinations as to make ten sets. In seven sets cast iron wheels were used while the Davis cast-steel wheels were used in the other three. New, medium new and old wheels were used so as to obtain as wide

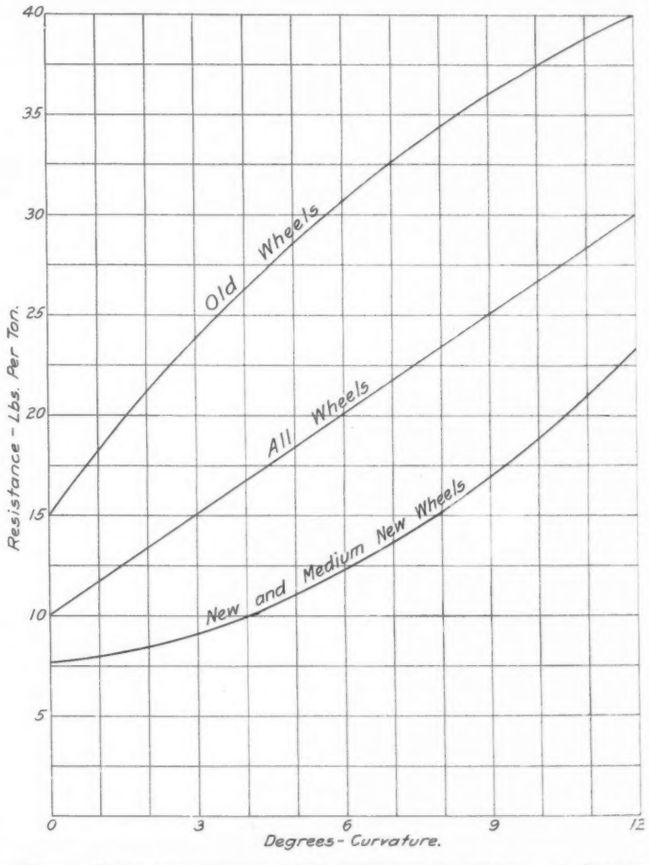


Fig. 1—Resistance Curves With Different Conditions of Wheels and on Various Curves.

a variation in wheel conditions as is met with in practice. The wheel sets were made up as follows:

Set A:—New cast iron wheels ground to M. C. B. standard contour and of the same diameter.

Set B:—Non-mated new cast iron wheels, one pair measured ⅛ in. difference in circumference and the other pair ¼ in.

Set C:—Davis cast steel wheels, M. C. B. contour, exactly mated.

Set D:—Medium new cast iron mated wheels.

Set E:—Same as Set D except that one diagonal pair of wheels were interchanged making the wheels unmated and the circumference of the wheel on one side 3/16 in. greater than on the other.

Set F:—Old cast iron mated wheels.

Set G:—Old cast iron non-mated wheels. There was a difference of 9/16 in. in the circumference of one pair and ½ in. in the other. The large wheels were on the same side of the truck.

Set H:—Medium old cast iron non-mated wheels. One pair was mated and the other had a difference of ½ in. in circumference.

Set I:—Special mated Davis cast steel wheels, made with height of flange ¾ in. and with no coning on the treads.

Set J:—Same as Set I except for a very slight non-mating.

*Abstracted from Professor Endsley's report to the American Steel Foundries.

RESULTS OF TESTS.

The method of testing was the same as in the first tests; also the determination of velocity and resistance in pounds per ton.

Tests to the number of 184 were made with the Andrews side frame truck and 146 with the arch bar truck. One of the principal objects of the tests was to obtain sufficient data on which to establish a conclusion as to the effect of different degrees of curvature on frictional resistance. The curves in Fig. 1 were obtained by finding the average resistance in pounds per ton for all truck and wheel conditions for new, medium new and old wheels, as recorded on the Andrews side frame truck. The straight line for all wheels which was established from the results from ten different sets of wheels, conforms to the generally accepted theory that the frictional resistance, for average operating conditions, increases in direct proportion to the degree of curvature. The only exception to this was the position of the point on the 3 deg. curve which was lower than that shown in the diagram. This may be due to the fact that the coning on the wheels keeps the flange out of contact with the rail, thus reducing the friction due to curvature up to about the 3 deg. curve, but at some point between the 3 deg. curve and the 6 deg. curve, the difference in length of the two rails is so great that the effect of coning is overcome.

The new and medium new wheel curve was obtained from tests made with sets A, B, C, D, E and H. Thus it is seen that when only good wheels are used the line is curved downward.

The curve shown for old wheels represents the relation that existed between the frictional resistance and degrees of curvature when the worst set of wheels were used, namely, Set F. This line curves in the opposite direction from that for new and medium new wheels.

INFLUENCE OF OLD RAILS.

The method of testing the old rails was the same as the new, so that the results are comparable. The curves shown in Fig. 2 were plotted from an average of all runs for all wheels used on the Andrews side frame truck and only on the 3 deg. and 6 deg. tracks. The per cent. increase of friction of the old rails over the new on the 3 deg. curve was 21.7 and on the 6 deg. curve 7.9.

Fig. 3 shows resistance for wheel sets A, B, C, D, E and H. The increase of friction of the old over the new rails on the 3 deg. curve was 20.8 per cent. and on the 6 deg. was 25.6 per cent.

Fig. 4 was plotted the same as Figs. 2 and 3, but the worst set of wheels was used. This difference between the resistance due to curvature on old and new rails when old wheels are used may be caused by the high flange of the old wheel coming in contact with the corner of the new rail at a point farther in advance of the point of contact of the tread of the wheel and the top of the rail than it would on a rail which has the corner worn away. In this way a greater flange friction would result, due to this increased leverage.

INFLUENCE OF WHEEL CONDITIONS ON TRUCK RESISTANCE.

The condition of the flanges and the tread of a set of wheels has quite an influence on the frictional resistance of a truck, regardless of its type. Table I shows to what extent the frictional resistance was affected by wheel contours. The sets of wheels are divided in five groups, as follows: Mated wheels (Sets A, C and D); non-mated new and medium new (Sets B and E); non-mated old (Sets F and G); non-mated medium old (Set H); and special, no coning (Sets I and J).

TABLE I.—AVERAGE RESISTANCES FOR DIFFERENT GROUPS OF WHEELS.

Track.	Wheel Set.				
	A-C-D	B & E	F & G	H	I & J
Tangent	6.90	7.53	12.82	9.96	14.25
3 deg. curve.....	8.43	7.99	19.50	14.08	21.27
6 deg. curve.....	10.40	11.43	30.03	20.22	33.79
12 deg. curve.....	20.10	25.20	37.70	28.16	45.97

From these values it is obvious that the condition of the mating and of the contours of the wheels has a very important bearing on the friction resistance of a truck. The flanges and treads of the first two groups of wheels were in good condition. The three remaining groups produced considerably more friction, due to the high and sharp flanges and to the absences of coning. From these results it is entirely obvious that the wheels should have as nearly perfect contours of flanges and treads as is practicable and that the wheels should be mated.

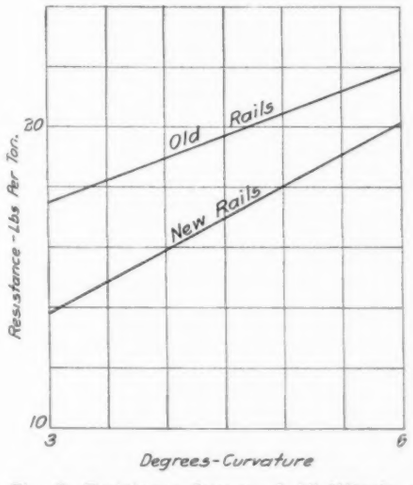


Fig. 2—Resistance Curves of All Wheels on Old and New Rails.

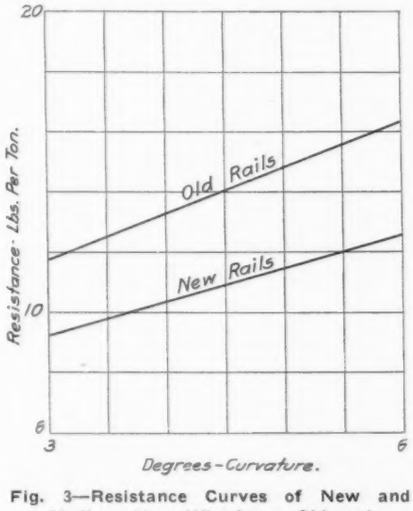


Fig. 3—Resistance Curves of New and Medium New Wheels on Old and New Rails.

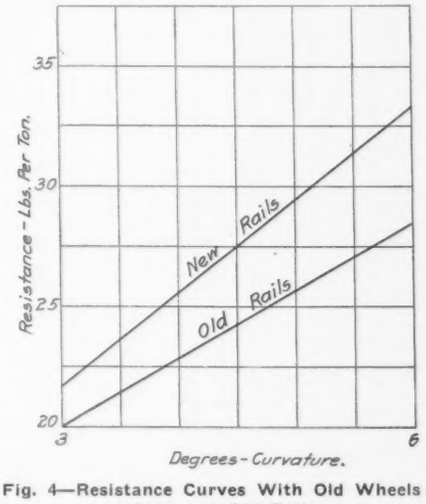


Fig. 4—Resistance Curves With Old Wheels on New and Old Rails.

COMPARISON OF SQUARE AND LOOSE TRUCKS.

The Andrews side frame truck was tested in both the loose and the square condition and the following diagrams were plotted from these tests. All of the ten sets of wheels were used. Fig. 5 shows resistance for all wheels tested on the new rails. The resistance curve for new and medium new wheels (sets A, B, C, D, E and H) are shown in Fig. 6. From Fig. 5 it will be seen that the saving in favor of the square truck varies from 3.54 per cent. on a straight track to 30.47 per cent. on a 12 deg. curve, and, taking 4 deg. as the average main line curve, the saving is 20.72 per cent. in favor of the squared truck, which checks very closely with the 1911 report.

EFFECT OF HOLDING TRUCK OUT OF SQUARE.

The arch bar truck, as already mentioned, was so constructed that it could be held out of square any desired amount. The average resistance for all wheels used in these tests, which were

sets A, D, E and F, and for all runs made on each track and for each amount the truck was held out of square was plotted and certain points in the curves are compared in Table II. It will be noted that on the tangent and on the 6 deg. and 12 deg. curves there was a decided change at 0.8 in. and that on the 3 deg. track this break occurs between 0.4 in. and 0.8 in.

Table II.—Average Resistance for All Wheels and Runs for Arch Bar Truck.

Track.	Amount Truck Was Held Out of Square (Inches).						
	0	0.4	0.8	1.2	1.6	2.0	2.4
Tangent	11.25	13.25	14.75	20.00	25.50	31.25	36.75
3 deg. curve.....	15.75	16.00	19.60	23.25	28.06	30.75	34.40
6 deg. curve.....	21.75	22.50	23.40	27.25	31.00	34.75	38.50
12 deg. curve.....	24.00	25.80	27.75	30.75	33.75	36.75	40.00

USE OF WINTER AND SUMMER OILS.

Tests were also made to determine the frictional resistance due to the use of winter and summer oils. They were made in the first week in November. The Andrews side frame truck with mated Davis cast steel wheels was used; the truck was square and was run on a tangent track. The analysis of the oil was as follows:

	Summer Oil.	Winter Oil.
Flashing point (degs. F.).....	386	240
Burning point (degs. F.).....	420	317
Specific gravity (Baume).....	21.5	24.5
Loss at 100 deg. F. for 3 hours.....	0.001	0.017
Ash (per cent.)	0.05	0.03
Cold test (degrees at which it flows).....	55	32
Viscosity at 350 deg. F. (time in seconds for 100 c. c. to flow from Dudley pipette).....	39	34

One hundred and forty-six tests were made and the average

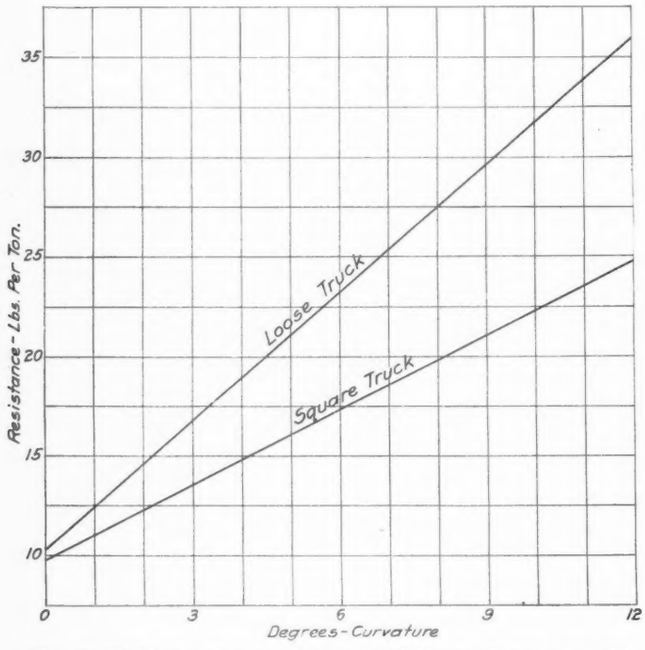


Fig. 5—Resistance Curves of Loose and Square Trucks for All Classes of Wheels.

resistance for the summer oil was taken at 14.77 lbs. per ton and 8.41 lbs. per ton for the winter oil, the average temperature for the former being 41 deg. F., and for the latter 48 deg. F.

CONCLUSIONS.

From the experiments made the following conclusions seem to be justified:

First. The curve friction of a freight car truck is almost directly proportional to the degree of curvature. If the wheels under the truck are new and in good condition, the increase of frictional resistance due to curvature is not so great on the flat degrees of curvature as it is on the sharp degrees. If the wheels under the truck are old and have flange heights approaching M. C. B. limits, just the reverse is true; that is, with old wheels the increase of frictional resistance due to curvature is greater for flat degrees than for sharp degrees of curvature.

Second. The frictional resistance of a truck equipped with wheels of average contour on new rails is from 10 to 25 per cent. less than for the same wheels on old rails. In the case of high flanges, on old wheels, however, this statement does not hold true.

Third. A truck equipped with old wheels and high flanges gives a frictional resistance of approximately 100 per cent. higher than that given when the truck is equipped with new wheels. The wheels should be exactly mated in order to give least resistance. The coning on the wheels is of great value in reducing the flange friction on low degrees of curvature.

Fourth. A truck constructed so that it will not get out of

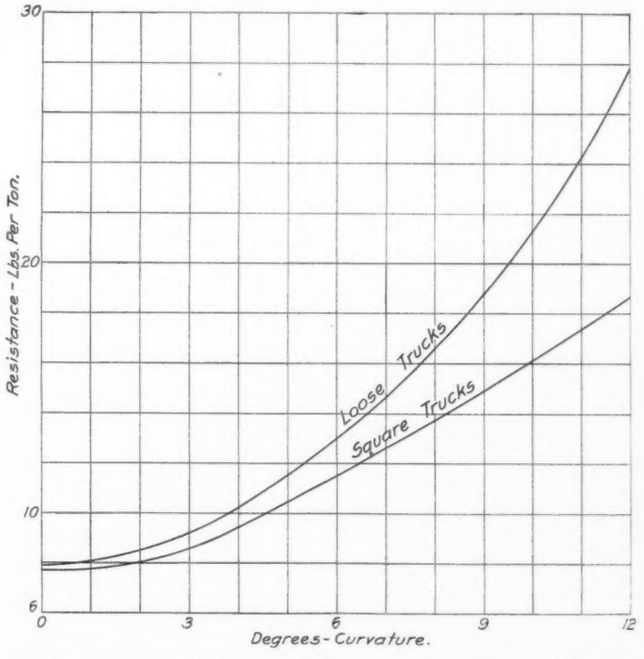


Fig. 6—Resistance Curves of Square and Loose Trucks With New and Medium New Wheels.

square will have less friction both on a tangent and on any degree of curvature than a truck that does not remain square.

Fifth. While the experiments with the winter and summer oils were not carried as far as they could have been, the results show that when the atmospheric temperature is from 40 to 50 deg. F. a truck lubricated with winter oil had about 43 per cent. less friction than one lubricated with summer oil, all other conditions being equal.

The Illinois Central furnished the wheels and axles and the Missouri Pacific the old rails used on the 3 deg. and 6 deg. tracks. L. W. Wallace, assistant professor of car and locomotive design at Purdue University, and L. C. Farquhar assisted Professor Endsley. A more detailed report of the tests will shortly be published by the American Steel Foundries.

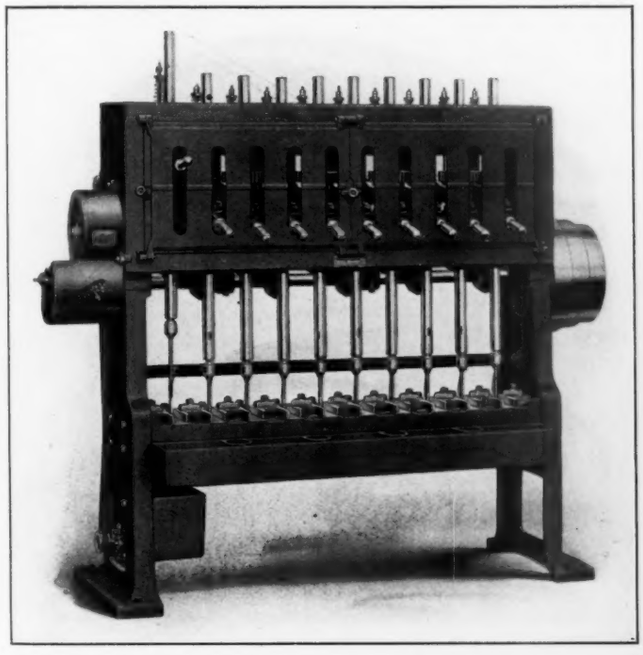
Value of Railways.—According to the estimates of the national wealth of the United States by the Bureau of the Census, the capital value of the railways (cost of road and equipment) increased but little more than half as fast as the capital value of all property from 1890 to 1904.

Southern Cotton Manufacturers.—Statistics of the Census Bureau issued August 31, 1912, indicate that the cotton-growing states used 2,712,622 bales for manufacturing purposes as against 2,655,049 in all the other states of the union. The number of spindles increased by about 500,000 over that operated the previous year.

NEW DEVICES

SEMI-AUTOMATIC NUT TAPPER

A new, ten-spindle 1½ in. semi-automatic nut tapping machine has been perfected by the National Machinery Company, Tiffin, Ohio. While somewhat similar to the 1 in. six-spindle machine designed by the same company, it embodies certain improvements, notably the gear box, which permits a rapid change of the spindle speeds at the operator's will and while the machine is running. This gear box takes the place of the removal and substitution of gears which was previously necessary. It is believed that the ease with which changes can be effected will prompt the operator to reduce the spindle revolutions as the taps are ground and the cutting teeth reduced



Ten-Spindle Semi-Automatic Nut Tapping Machine.

in number, so that there will be little or no idle tapping time—taps running free in the nut after it is tapped—which tends to reduce maximum output.

The spindles are raised and lowered by cams. Through this automatic spindle movement, the machine sets the pace of the operation, and the operator can devote his entire energy to feeding. Trials have demonstrated that operators have no trouble in meeting the uniform pace set by the machine throughout a working day. This method of raising and lowering the spindles also tends to prolong the life of the taps, as the spindle descends gradually, and the tap is not subjected to sudden and excessive torsional strains. The cams have three steps, and by shifting the cam shaft, the resting time of the spindles when raised can be altered to meet the needs of the operator for feeding.

The spindles are close together—the ten spindles being within a space of 69 in.—which facilitates feeding, and enables the operator to successfully handle ten spindles without covering much floor space. The machine has sufficient range and power to tap two nuts of the smaller sizes on all spindles simultaneously.

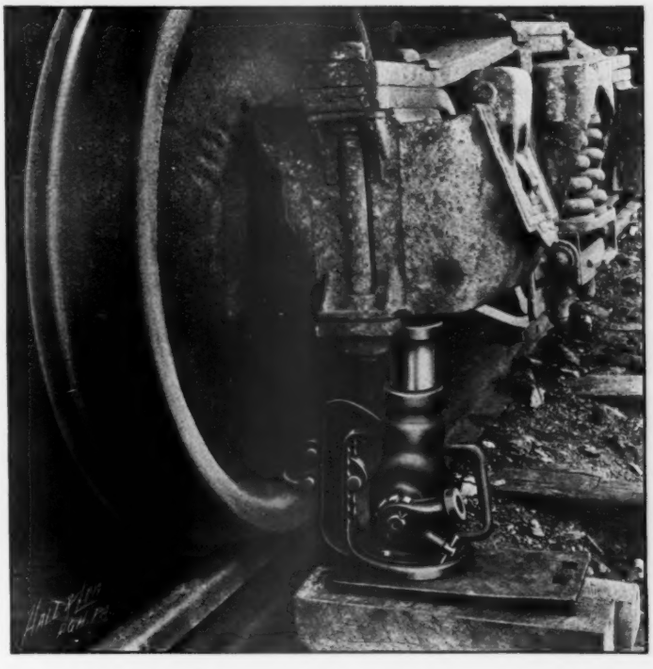
The nut holders are of simple design. The nut guides are chilled plates of wedge shape, held in position by toe clamps. The guides are backed by stationary lugs of corresponding angle on the feed table, thus making the guides rigid and insuring the parallel position of the guide faces. The guides have no tendency to shift or spring, and there is, therefore, freedom from binding of the nuts when feeding.

Openings are provided in the nut pans through which the operator can empty the taps in boxes or kegs set beneath the tapper. This machine will handle either rough hot pressed, or cold punched nuts.

NEW DESIGN OF JOURNAL JACK

A 15-ton, ball bearing jack, especially designed for use in connection with the inspection, removal, or replacement of journal brasses in freight and passenger cars, or for any service where a short, light, powerful jack is required, has been perfected by the Duff Manufacturing Company, Pittsburgh, Pa.

These jacks are said to be very easy operating, because of the large ball bearings which carry the load, and the fact that all parts are machine finished. The steel gears have machine cut teeth and are heat treated. They are self-lubricating, the interiors being packed with semi-fluid grease in which all moving parts revolve. A new positive stop is used, which prevents the lifting bar from running too far out of the jack, and accidents from this cause are impossible. The load is raised on the downward movement of the lever.



New Ball Bearing Journal Jack in Operation.

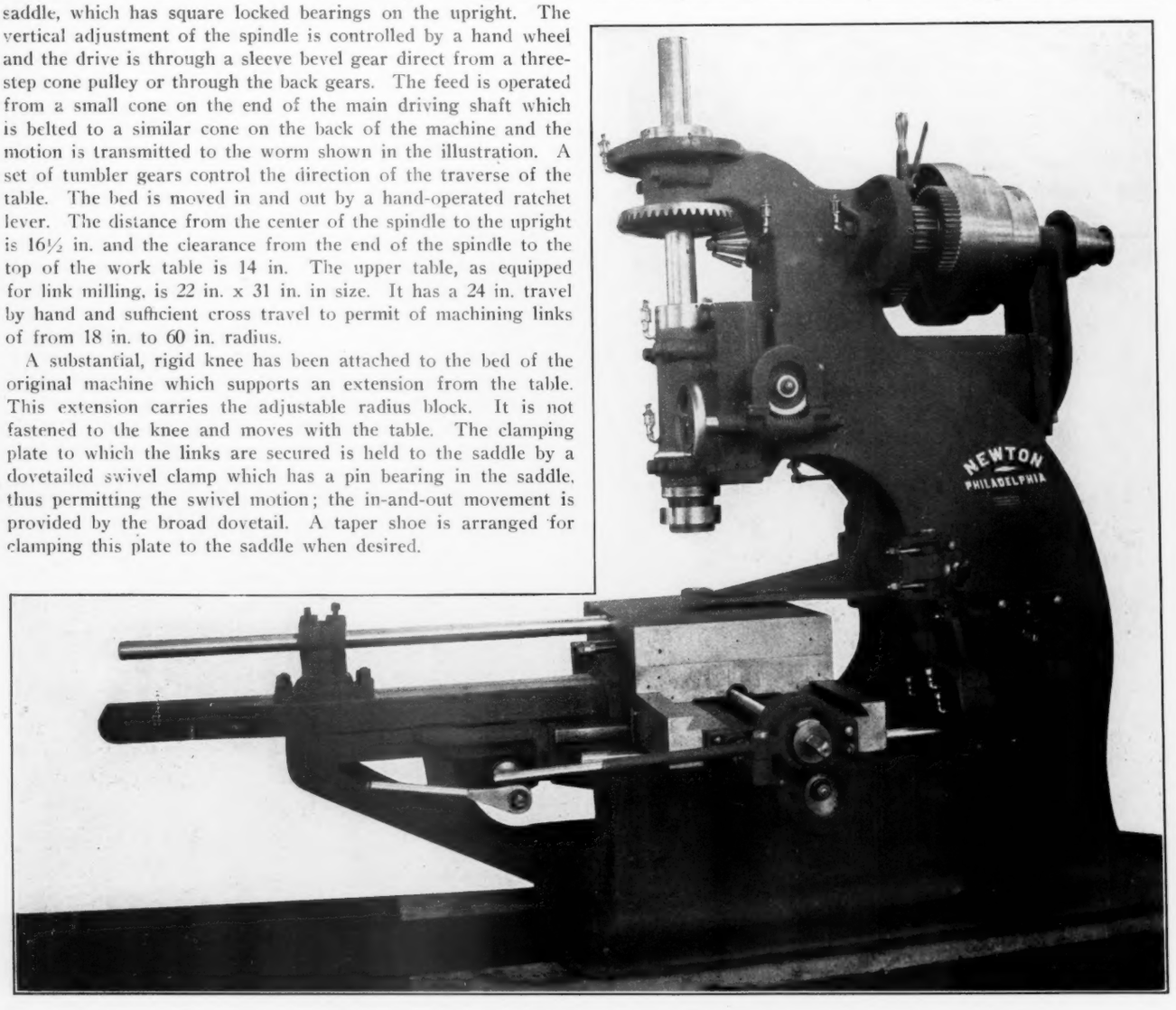
An adjustable wheel-holding device holds the wheel firmly on the track while the journal box is being raised, and does away with the necessity of wedging down the wheel, or of using a plate or strap, can be furnished if desired.

These jacks are light for their capacities, weighing only 28 lbs. without the wheel-holding device, and 33 lbs. with it.

LOCOMOTIVE LINK MILLING MACHINE

The Newton Machine Tool Works, Philadelphia, Pa., has recently arranged its standard No. 2 vertical milling machine to make it suitable for milling the valve gear links of locomotives, or other work on arcs of similar radii. This type of milling machine has been in successful use on heavy work for a number of years, and the attachment for links is so arranged as to not materially interfere with its use on straight work. The spindle has a double taper bearing, the large end of which is approximately 4 in. in diameter. It revolves in bronze bushed cap bearings in the saddle, which has square locked bearings on the upright. The vertical adjustment of the spindle is controlled by a hand wheel and the drive is through a sleeve bevel gear direct from a three-step cone pulley or through the back gears. The feed is operated from a small cone on the end of the main driving shaft which is belted to a similar cone on the back of the machine and the motion is transmitted to the worm shown in the illustration. A set of tumbler gears control the direction of the traverse of the table. The bed is moved in and out by a hand-operated ratchet lever. The distance from the center of the spindle to the upright is 16½ in. and the clearance from the end of the spindle to the top of the work table is 14 in. The upper table, as equipped for link milling, is 22 in. x 31 in. in size. It has a 24 in. travel by hand and sufficient cross travel to permit of machining links of from 18 in. to 60 in. radius.

A substantial, rigid knee has been attached to the bed of the original machine which supports an extension from the table. This extension carries the adjustable radius block. It is not fastened to the knee and moves with the table. The clamping plate to which the links are secured is held to the saddle by a dovetailed swivel clamp which has a pin bearing in the saddle, thus permitting the swivel motion; the in-and-out movement is provided by the broad dovetail. A taper shoe is arranged for clamping this plate to the saddle when desired.



Vertical Milling Machine with Attachment for Machining Locomotive Links.

A lower cutter arbor support has been provided on the machine and is hinged on one side, so that it may be swung out of the way if desired. The device customarily used for holding links is so arranged as to clear this arbor support. The machine weighs about 13,000 lbs. and occupies an actual floor area of 6 ft. x 3 ft.

Smoke Consumers.—The report of the building inspector of Louisville, Ky., shows that during the fiscal year 1912, which terminated August 31, 100 boilers with smoke consumers were installed. The inspector states that practically all of the permits issued were for high-pressure boilers suitably equipped with approved smoke consumers.

REVERSING MOTOR DRIVE FOR PLANERS

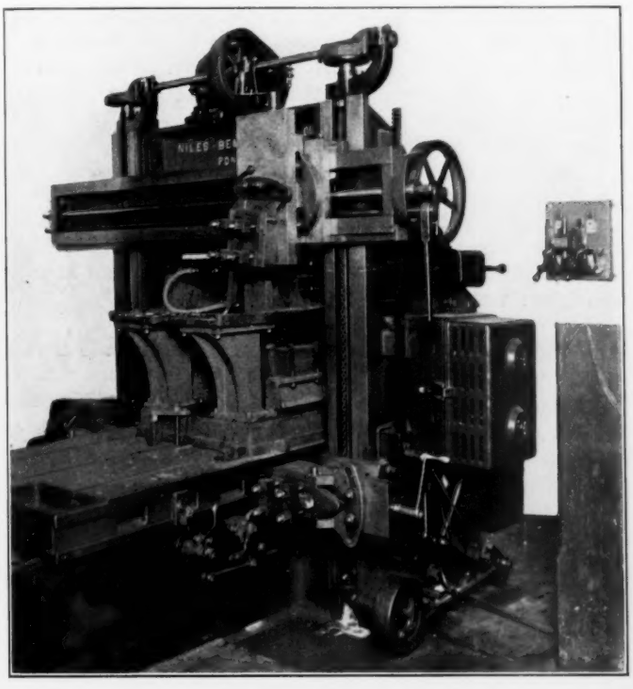
The idea of applying direct connected reversing motors to planers has been in practice for some eight or ten years, although it has been more or less of an experiment up to a year or so ago. The use of this form of drive, even in the first stages of its development, showed that it possessed many advantages over the usual methods of reversing through clutches or belt shifters. Not only is an economy effected in the consumption of power through the application of the principle of direct connected individual operation, but the maximum cutting speeds are sustained uniformly, the acceleration is more rapid on the return travel, and an increased production is possible.

The effective performance of this drive has created a demand that has warranted exhaustive study and tests by manufacturers in developing it for commercial purposes, and the General Electric Company, Schenectady, N. Y., has recently placed on the market a reversing, adjustable speed, direct connected motor drive that has been carefully tested and tried out in service.

Probably the most interesting application of this drive to machine tools is to planers, but the application to other types of machine tools has proved practical, and it is now used to drive, screw, worm and rack driven slotters, turret lathes, wire and tube drawing machinery and other classes of machine tools usually

reversed through clutches or shifting belts. The motors are mounted any place on the machine or floor convenient for mechanical connection. They are of the standard commutating pole type up to and including 100 h. p. planer rating. The combinations of speeds obtainable allow the motor, in the majority of cases, to be coupled direct to the driving shaft of the machine.

The control consists of a contactor panel and master switch. The former is usually mounted on the side of the planer housing,



Reversing Motor Drive on a Large Planer.

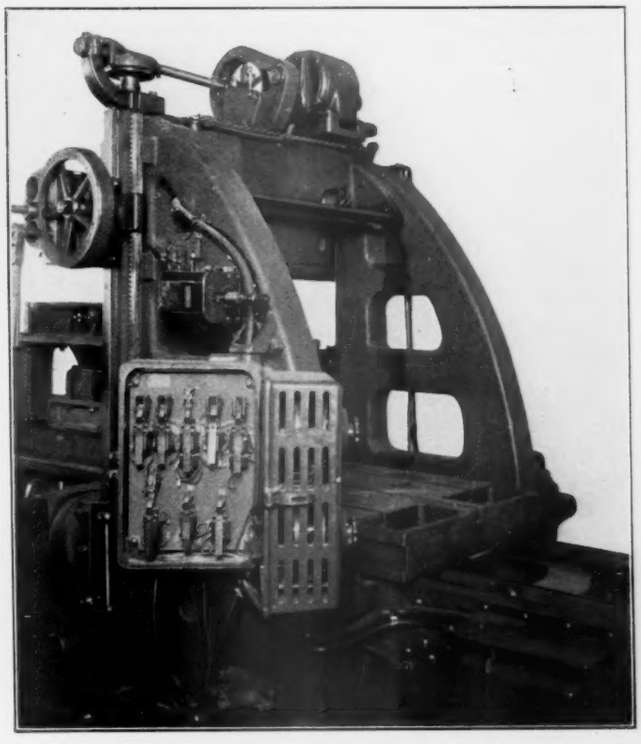
or in any convenient place on other machine tools to which the drive may be applied. It is made up of eight contactors, similar in appearance to a series contactor, but actuated by shunt, series or differential coils in such a manner as to eliminate electrical disk interlocks. An additional precaution is taken by using mechanical interlocks to prevent the possibility of short circuits. The panel, field rheostats and all accessories are enclosed in a cast iron box, the cover of which is hinged, so that, when swung open, the contactors are easily accessible. The box itself is pivoted in order that the rear of the panel may be swung into view for inspection when required. The field rheostat handles are brought out through the cover of the enclosing case and are plainly marked "cut" and "return." The pointers of these handles traverse a blank ring, which can be marked or graduated for cutting and return speeds in feet per minute.

The master switch is usually mounted on the side of the planer bed, or in other convenient place. This switch is of simple design, containing only four contact fingers, two forward and two reverse, one being used in common for both directions, and three segments on the drum, all of liberal proportions. Its sole function is to close the shunt coil circuits of the forward and return line contactors. The motor field is entirely external to the master switch. The master switch is operated by dogs on the planer table in much the same way as is now employed for shifting the belts. A special double pole circuit breaker is also supplied, which provides for minimum voltage and overload protection. In case the breaker opens or current fails, it automatically stops the motor, preventing the platen from coasting off the ways.

By virtue of the commutating pole design of the motor, starting, stopping and reversing are accomplished with sparkless commutation. In order not to brake dynamically from high speed in one violent step, means have been taken to accomplish this in three distinct steps, braking down slowly from high speeds and then quickening the brake action at lower speeds. This feature, in addition to quickening the brake, will be recognized as a decided advantage in the maintenance of the machine. A noteworthy point in connection with the operation of this drive is that the planer table reverses extremely close to a line at the end of the cut.

The cutting and return speeds are entirely independent of each other, so that it is possible to use the slowest cutting speed and the highest return speed, or vice versa, in any combination not exceeding four to one, with 35 to 70 cutting speeds and the same number of return speeds.

The saving obtainable by applying power direct to machine tools is considered as the amount of friction load that has thus been eliminated. This often reaches as much as 50 per cent., yet it is in reality only a small part of what may be realized, as proved by numerous tests. A belt driven planer, or other machine, of approximately 10 horsepower capacity, running at



Arrangement of Contactor Panel for Reversing Motor Drive.

Machine. Type.	Machine. Size.	Type Drive.	Size Motor. H. P.	Input. Amp.	Cut. In.	Stroke.	Not Cutting. Ft. per Min.	Not Cutting. Time. Sec.	Cutting. Ft. per Min.	Cutting. Time. Sec.	Return. Ft. per Min.	Return. Time. Sec.	Cut. Total Cycle. Sec.
Planer	36 in. x 10 ft.	Belt	10	33	⅜ x ⅞	8 ft. 6 in.	31.9	16	28.3	18	72.8	7	25
Planer	36 in. x 10 ft.	Reversing	10	51	⅜ x ⅞	8 ft. 6 in.	53.2	9.6	52.7	9.8	91	5.6	15.4
Planer	36 in. x 10 ft.	Belt	10	38.5	½ x ⅞	8 ft. 6 in.	33.3	15.4	28	18.2	72.8	7	25.2
Planer	36 in. x 10 ft.	Reversing	10	56	½ x ⅞	8 ft. 6 in.	53.7	9.5	53.2	9.7	91	5.6	15.3
Planer	72 in. x 22 ft.	Belt	40	95	½ x ⅞ 1 x ⅞	10 ft. 1 in.	22.9	26.4	17.1	35.4	59.3	10.2	45.6
Planer	72 in. x 22 ft.	Reversing	35	120	½ x ⅞ 1 x ⅞	10 ft. 1 in.	34.8	17.4	34.4	17.6	75.7	8.2	25.8

a cutting speed of 25 ft. per minute, will drop in speed 2½ to 5 ft. per minute, or 10 to 20 per cent., while cutting to a value of 10 horsepower, if this approaches the carrying capacity of the belt, due to size, speed or slackness. If the cutting speed be increased by 50 per cent. with the same depth of cut and feed, the speed will fall while cutting to nearly what it was originally, the power input increasing only slightly or to the limit of the belt capacity. The maximum slip will be reached when the machine is stalled, the power input remaining approximately constant and the loss being entirely due to friction from belt slippage This slippage loss is demonstrated in the tabulation of tests made with a recording ammeter and given on page 47. The motors used were all 230 volt. The speeds noted are average feet per minute for complete cutting and return strokes.

HYDRO-PNEUMATIC ACCUMULATOR

Accumulators are a necessary adjunct to hydraulic riveters, presses, punches, etc. While the heavily weighted type are the simplest and are generally used, it occasionally happens that their size and weight are a serious consideration. This is especially true when the tools are to be located on the upper floors of a building.

For use under any conditions that make a weighted accumulator undesirable, the Watson-Stillman Company, New York, has designed and perfected a hydro-pneumatic accumulator which, it

Arrangement of High and Low Pressure Accumulator.

is claimed, will satisfactorily perform all the functions of the weighted type and in addition will provide two pressures, a high pressure of from 300 to 6,000 lbs., as desired, and a low pressure for effecting that part of the stroke which is made against no resistance. The operating valve used in connection with this system requires no more wheels or levers than the ordinary valve and the change from low to high pressure is made automatically at the instant the ram encounters a resistance which the low pressure cannot overcome.

This type of accumulator is shown in the illustration. In the center is a large steel tank kept partially filled with water by the low pressure pump, the operation of which is controlled by the hydraulic governor shown at the left of the tank. By its action, when the water reaches a predetermined level in the tank, the pump is stopped and when it falls below this level the pump is started. Above the water an air pressure of 180 to 200 lbs. is maintained by the compressor shown at the extreme left. The low pressure feed main is tapped into the bottom of this tank and the water is forced through it by the pressure of the air.

The air pressure is also piped to the accumulator proper and by the force it exerts on a piston in the large cylinder at the top, it balances the higher pressure from the hydraulic pump acting on the piston in the small cylinder at the bottom. The areas of these pistons are inversely proportional to the pressures on them. The operation of the regular high pressure hydraulic pump is controlled by the governor shown on the front of the accumulator, in the same manner as the low pressure pump is controlled. The pumps are operated only when their supply is required and there is no waste of power as high pressure is not used when low pressure suffices. This type of accumulator can be used for high pressures only by omitting the low pressure pump and its connection to the air tank.

HORIZONTAL MILLING MACHINE TESTS

For the past 11 years Alfred Herbert, Limited, machine tool builders, of Coventry, England, have maintained a special shop for the purpose of trying out new forms of machine tools. One of these tests on a horizontal milling machine was described by P. V. Vernon in a paper read before the Manchester Association of Engineers, November 23. The machine had the following general characteristics:

Longitudinal feed.....42 in.	Number of speeds.....16
Transverse feed .....13½ in.	Range of speeds.....16.4 to 427
Vertical feed .....21 in.	Number of feeds.....18
Diameter of single pulley....16 in.	Range of feeds (inches per minute) .....5⅝ to 22½
Speed of pulley.....400 r. p. m.	Weight of machine.....8,652 lbs.
Belt speed .....1,675 ft. per min.	
Maximum gear ratio.....24.4 to 1	

The machine was driven by a 30 horsepower d. c. motor, which would stand 20 per cent. overload for two hours. In a test with a 3½-in. high speed, 8-tooth cutter, milling an 8-in. cast iron block at 70 ft. per minute (cutting speed), the largest amount of metal removed per horsepower minute was 1.78 cu. in. and the least was 1.04 cu. in. On a test with a 4½-in. high speed, 10-tooth cutter on a cast iron block 8 in. wide at a cutting speed of 70 ft. per minute, the greatest amount of metal removed per horsepower minute was 1.84 cu. in. and the least was 0.86. In another test on an 8-in. mild steel block with a 4½-in. high speed, 10-tooth motor running at 70 ft. per minute, the maximum net horsepower obtained was 42.1 and the least 24.9. The greatest amount of metal per horsepower minute removed was 0.74 cu. in. and the least 0.57. The machine failed while operating a 4½-in. cutter 9 in. long and the defects were noted. After correcting these defects a final test was successfully made with a 4½-in. high speed steel cutter 9 in. long carried on a 2-in. arbor. The cutter had 10 teeth and the angle of the spiral was 26¾ deg., the cutter being run at 70 ft. per minute. In the conclusion, Mr. Vernon made the following generalizations:

A 5-in. double belt driving a 16-in. pulley at a speed of 400 r. p. m. (100.531 sq. in. of belt per minute), geared to drive a 4½-in. cutter at 70 ft. per minute, is able to remove as much as 48.1 cu. in. of cast iron, and 24.31 cu. in. of mild steel in a minute.

2,090 sq. in. of double belt passing over a pulley in a minute will remove 1 cu. in. of cast iron on a milling-machine.

4,135 sq. in. of double belt passing over a pulley in a minute will remove 1 cu. in. of mild steel on a milling-machine.

A 4½-in. cutter on a 2-in. arbor, running at 70 ft. per minute, is capable of removing at least 3.63 cu. in., and possibly as much as 6.01 cu. in. of cast iron, and at least 2.125 cu. in., and possibly as much as 3.03 cu. in. of mild steel per minute for each inch of width up to 8 in., and at any depth of cut from 0.24 in. to 1.1 in.

NEWS DEPARTMENT

The Chicago, Milwaukee & Puget Sound hereafter will be operated as the Puget Sound Lines of the Chicago, Milwaukee & St. Paul.

A $5 gold piece was given, as a Christmas present, to each employee of the Interborough Rapid Transit Company, New York City, who received less than $110 a month.

Schools of telegraphy have been established by the Western Union Telegraph Company at its offices in a large number of cities, so that all employees may have the opportunity of learning the art.

A competition for the best letter of not over 250 words on "Safety First" has been announced by the St. Louis & San Francisco. It is open to all women in the families of Frisco employees. Prizes of $10, $5 and $2.50 will be awarded.

The San Pedro, Los Angeles & Salt Lake announces that a small open gasolene motor car, with accommodations for about eight passengers and a small quantity of light baggage, has been put in service on the St. Thomas Branch from Moapa (Nevada) to St. Thomas, about 20 miles.

From a statement of casualties issued by the Central Safety Committee of the St. Louis & San Francisco for the month of November, 1912, as compared with the same month in 1911, it was shown that the casualties decreased from 464 to 334, or 28 per cent., and the casualties to employees from 399 to 257, or 36 per cent.

To remove temptation as far as possible from the employees of the Chicago, Burlington & Quincy, that road has issued an order prohibiting the men from cashing their pay checks in saloons. Arrangements have been made with the local banks to keep open the evenings of pay days to accommodate the men. One saloonkeeper in Aurora is said to have cashed over $15,000 worth of checks in a single night.

A bill has been introduced in the lower house by Representative Raker, requiring the interstate roads to equip locomotives with headlights of not less than 1,500 c. p. measured without the aid of a reflector. The law does not apply if the headlight equipment shall fail on a trip provided it can be shown that it was in good order when the trip was begun. The penalty is from $100 to $1,000, and every day will be considered a separate offense.

A good illustration of the type of men holding responsible positions on our railways and the training that they have received was shown by an event that occurred on the Denver & Rio Grande recently. The engineman and fireman of a special train on which A. P. Anderson, the general superintendent, and N. A. Williams, superintendent, were proceeding to Salt Lake City, had been on duty 16 hours. Rather than delay the trip Mr. Anderson and Mr. Williams donned the engineer's and fireman's overalls and carried the train through without any mishap, allowing the engine crew to rest in the superintendent's car.

A conference is being held in New York City between a committee representing the eastern railways and the leaders of the locomotive firemen concerning the increase in firemen's wages. At one of the recent meetings the firemen withdrew their demand for time and a half for overtime and modified their demand for extra firemen on all engines. It has been stated that to meet the original demand of the firemen would cost the roads interested $20,800,000 a year, and under the changed terms of the demand it would still be large, about $15,134,000, which would be 56 per cent. of the firemen's present wages.

A settlement has been reached between the striking western machinists of the Grand Trunk Pacific and President E. J. Chamberlin, which will clear the way for the opening of the Transcona shops. The company agrees to reinstate all strikers who apply within 30 days. For the present the existing rate of pay and rules will prevail, 45 cents an hour for Rivers and east of Rivers, and 47½ cents west of Rivers. The company agrees that next spring, if the men so desire, the western management will meet a committee of the men to decide upon a new agreement and a new schedule, and failing to arrive at terms the differences will be submitted to a conciliation board appointed under the Industrial Disputes Act.

A circular has been issued by President B. L. Winchell, of the St. Louis & San Francisco, announcing a pension plan for the St. Louis & San Francisco, the Ft. Worth & Rio Grande, the St. Louis, San Francisco & Texas and the Paris & Great Northern, as follows:

"It has been determined that a plan for granting pensions to employees of these companies, for superannuation or disability, following long service on these lines, shall be made effective from July 1, 1913. Details of the plan will be announced before that date. In the meantime, it is thought that this advance notice may bring encouragement to the employees as a whole, as well as comfort and holiday cheer to some of those who are approaching years of retirement." The circular is also "Heartily Approved" by B. F. Yoakum.

Several commissions have been appointed in Switzerland to investigate the practicability of electrifying the Swiss state railways. The fact that Switzerland produces no coal makes the cost of fuel for operating steam railways an important item, and the fact that the state controls the vast amount of available water power for the generation of electricity makes the proposition more feasible. One commission has reported in favor of the single-phase alternating current system, operating at 15,000 volts. The first work to be undertaken in the application of electricity on state railways will be on the St. Gotthard route, where there are many steep grades and numerous tunnels, the longest of which is over 9 miles. The estimated cost of the conversion of the entire government system, aggregating 1,700 miles, will be about $14,000,000, including the water power for electrical operation, and the cost of operation will be reduced 10 per cent.

Captain Robert W. Hunt, senior member of the firm of R. W. Hunt & Co., Chicago, was, on December 5, presented with the John Fritz medal for 1912 in recognition of his achievements in the application of the Bessemer process to steel manufacture. Mr. Hunt was born at Fallsington, Pa., in 1838, and received his education at Covington, Ky. In 1860 he established the first chemical laboratory in America to be operated as a department of an iron and steel manufacturing plant, at the works of the Cambria Iron Co., Johnstown, Pa. He left this company to serve through the Civil War, returning to the firm in 1865. He was then sent to Wyandotte, Mich., to assist in establishing a Bessemer plant at that place. He returned to Johnstown in 1866 and assisted in the design and construction of the Cambria Iron Co.'s Bessemer plant, of which he had charge from 1871 to 1873. He later became superintendent of the Bessemer works of John A. Griswold & Co., at Troy, N. Y., and upon the formation of the Troy Steel & Iron Co., in 1875, was appointed manager, which position he retained until 1888. He then established the testing and inspection bureau in Chicago, which bears his name and of which he is still the head. Capt. Hunt is a past president of the American Institute of Mining Engineers, having served two

terms, in 1883-4 and 1906-7. He was president of the American Society of Mechanical Engineers in 1890 and 1891 and was elected president of the Western Society of Engineers in 1893. He is the inventor of numerous steel and iron metallurgical processes and collaborated in the design of the Hunt-Jones-Suppes rail mill feed table. In recent years he has devoted much time to a study of steel rails.

A CORRECTION

In the article on "The Manufacture of Brake Beam Hangers" in the December, 1912, issue of the *American Engineer*, the brake cylinders used in connection with the bending machine shown in Fig. 5 should have been given as 14 in. x 12 in. in size, instead of 12 in. x 12 in. The last sentence of the article should read: "The hourly wages of the three men aggregate 56 cents, and their piece work earnings, at 5 cents per hanger, amount to from 65 to 70 cents per hour." A typographical error caused the last part of the sentence to read "55 to 70 cents per hour."

DEATH AND INJURY BENEFITS FOR GOVERNMENT EMPLOYEES

The solicitor for the Department of Commerce and Labor, in a report summarizing his decisions under the law of May 30, 1908, providing for compensation to certain government employees in cases of injuries, fatal or non-fatal, received in the course of their employment, presents a statement showing that in about three years more than $800,000 has been thus paid out. The report says:

"The act has been in operation since August 1, 1908. Between that date and December 1, 1911, compensation was paid in 5,564 cases of injury, in 165 of which the injury resulted in death. On account of these fatal injuries $112,879 has been paid to surviving dependents. On account of the non-fatal injuries $704,815 has been paid to the injured persons themselves. (The figures given do not refer to claims arising on the Isthmian Canal since March 3, 1911, when the Isthmian Canal Commission was authorized to handle such claims directly.) These payments have been made, not out of any special appropriation, but from the ordinary current appropriations for salaries. The salary has simply been paid as if the injured man continued at his work, until his incapacity ceased or until the year had run. Owing to the limited scope of the act there have been naturally more accidents reported than claims filed, and there have been also a number of claims filed which could not be allowed either because they were not within the act or were not properly established. In the first year, the number of injuries reported was 4,862, and the number of fatalities 233, while the number of claims submitted was but 1,805, of which 1,689 were allowed. During the second year 6,984 accidents were reported and 226 fatalities; 2,624 claims were submitted and 2,499 allowed. Legislation to extend the benefits of the act has been recommended by the Secretary of Commerce and Labor, and measures designed to enlarge the scope of the act are now pending in Congress."

MEETINGS AND CONVENTIONS

Northern Railway Club.—A. G. Johnson, chief draftsman, Duluth & Iron Range, presented a paper on locomotive counterbalancing at the November meeting. This paper was largely made up of quotations from different books, being principally taken from "Locomotive Operation," by G. R. Henderson.

New York Railroad Club.—The December meeting was given up to the annual Christmas entertainment and smoker which, in recent years has become so popular as to tax the capacity of the auditorium. The usual high character of entertainment was provided. A large silver loving cup was presented to Frank Hedley, the retiring president.

Western Railway Club.—A paper was presented by O. S. Beyer, Jr., of the Rock Island Lines, before the club, December 17, on Railway Specifications. The following committee was also appointed to report on the proposed changes in the M. C. B. Rules of Interchange: George Thompson, New York Central Lines, chairman; G. F. Laughlin, Armour Car Lines; H. H. Harvey, Chicago, Burlington & Quincy; J. M. Borrowdale, Illinois Central, and C. J. Wymer, Chicago & Western Indiana.

General Foremen's Association.—At a joint meeting of the executive committees of the International Railway General Foremen's Association, the American Railway Tool Foremen's Association and the Supplymen's Associations, held at the Hotel Sherman, Chicago, December 18, 1912, it was decided to hold the next convention of the International Railway General Foremen's Association, in Chicago, July 15-18, 1913, at the Hotel Sherman. This is one week earlier than usual; the Tool Foremen's Association will meet the following week, at the same place, and the exhibitors will thus find it possible to use the same exhibit for both associations.

Railway Business Association.—The annual business meeting of this association was held on December 19; the report of President George A. Post indicated very satisfactory developments from the efforts of the association in favor of a policy permitting adequate railway revenue. Mr. Post was re-elected president. Approximately a thousand members and guests were present at the annual dinner in the evening. The speakers of the evening were James J. Hill and the Hon. W. L. MacKenzie King. The former spoke on the need of greater railway facilities for the proper commercial development of the country and presented striking statistics in connection with the capitalization of the railways in this country and abroad. Mr. King, formerly Minister of Labor of Canada, explained the origin and results of the Canadian industrial disputes investigation act which has now been in operation for practically six years.

American Society of Mechanical Engineers.—At the annual meeting in New York, December 3-6, the following officers were elected for the ensuing year: President, W. F. M. Goss, dean of the Engineering School, University of Illinois; vice-presidents, James Hartness, J. E. Moultrop and H. G. Stott; managers, W. B. Jackson, H. M. Leland and Alfred Noble; treasurer, W. H. Wiley. The members of the society at the University of Illinois, with the heads of the engineering departments, gave a dinner to Dr. Goss on December 13, at the University Club in Urbana, Ill., as an expression of their appreciation of his election to the presidency. On December 18, a special engineering convocation was held to permit the general faculty and the students in the college of engineering to

RAILROAD CLUB MEETINGS

Club.	Next Meeting.	Title of Paper.	Author.	Secretary.	Address.
Canadian	Jan. 14	Terminals	C. L. Fritch	Jas. Powell	Room 13, Windsor Hotel, Montreal.
Central	Jan. 9	Freight Car Tactics	Arthur Hale	H. D. Vought	95 Liberty St., New York.
New England	Jan. 17	Steel Freight Cars	Chas. Lindstrom	Wm. E. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Jan. 17	Pneumatic-Electric Brake	N. A. Camel	H. D. Vought	95 Liberty St., New York.
Pittsburgh	Jan. 24	Terminal Car Service	W. M. Prall	J. B. Anderson	Union Station, Pittsburgh, Pa.
Richmond	Jan. 13	Lecture on Bermuda	S. H. Bowman	F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	Jan. 10		W. W. Finley	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Jan. 20	Increased Locomotive Capacity Resulting from the Use of Superheated Steam	Gilbert E. Ryder	Jos. W. Taylor	390 Old Colony Bldg., Chicago.

express their appreciation of the honor paid Dean Goss. After several brief addresses, Prof. Ira O. Baker presented to Dean Goss an engrossed testimonial signed by representatives of the faculty and the various engineering organizations at the university.

Canadian Railway Club.—Prof. V. I. Smart, of McGill University, presented a paper at the November meeting on the subject of prevention of accidents. He tabulated a large amount of information on casualties in connection with train operation and discussed the greater safety to passengers on foreign railways as compared with those in this country. He briefly investigated the reasons for this difference in conditions, concluding that the form of block system for train operation used in Europe is principally responsible for the greater safety. He also considered briefly the cost of block signal systems and depreciated the relative value of the manual control block system. The discussion was confined principally to the methods of despatching and forms of signaling. At the December meeting the paper presented by S. P. Brown was on the subject of tunneling. It included an extensive discussion of the latest development in building railroad tunnels and all of the more important factors to be considered in the engineering and construction work.

Railway Storekeepers' Association.—The tenth annual meeting of this association will be held at the Auditorium Hotel, Chicago, May 19-21, 1913. The regular subjects which will be considered are as follows: Reducing of inactive and disposing of obsolete stock; economy effected by the use of rolling mills at railroad scrap docks; marking of M. C. B. couplers and parts by manufacturers for identification. What effect, if any, has a well organized store department on the operating cost of a railroad? Among the topical subjects to be discussed are the following: Standard storehouse, standard storehouse casting platform, standard oil house and waste storage, standard dry lumber sheds, standard stationary storehouse, standard supply car, and standard scrap dock and reclaiming machinery. These will be exemplified by the necessary drawings arranged on a unit basis, so that any road may draw on such standards according to its requirements. The following subjects will also be considered: Specifications for and the testing of material and effect on the storekeepers' stock; the proper method of storing, disbursing and handling of ice on railroads; and the standard book of rules governing store department practices.

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations.

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass. Convention, May 6-9, 1913, St. Louis, Mo.

AMERICAN RAILWAY MASTER MECHANICS' ASSOC.—J. W. Taylor, Old Colony building, Chicago. Convention, June 11-13, 1913, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—A. R. Davis, Central of Georgia, Macon, Ga.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa. Annual convention, June, 1913.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Annual meeting, December 3-6, Engineering Societies' Building, New York. Railroad session, Thursday morning, December 5.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 North Fiftieth Court, Chicago; 2d Monday in month, Chicago.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. G. Hall, McCormick building, Chicago. Convention, May, 1913, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, Chicago & North Western, Escanaba, Mich.

INTERNATIONAL RAILROAD MASTER BLACKSMITH'S ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August 18, 1913. Richmond, Va.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York. Convention, May 26-29, 1913, Chicago.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Old Colony building, Chicago. Convention, June 16-18, 1913, Atlantic City, N. J.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC. OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, Sept 9-12, 1913, Ottawa, Can.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, May 19-21, 1913, Auditorium Hotel, Chicago, Ill.

PERSONALS

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

FREDERICK S. BROWN has been appointed mechanical engineer of the Erie, with headquarters at Meadville, Pa.

H. E. DALZELL has been appointed chief of motive power and machinery of the Southern Railways of Peru and dependencies, with headquarters at Arequipa, Peru.

LEWIS D. FREEMAN has been appointed chief draftsman of the Kansas City Southern, with headquarters at Pittsburg, Kan. Mr. Freeman was born at Gettysburg, Pa., on July 11, 1888, and attended the common schools and high school at that place. He served an apprenticeship at the Baldwin Locomotive Works, Philadelphia, Pa., studied three years at night school, and took correspondence school courses in mechanical engineering and the air brake. From November, 1909, to March, 1910, he was employed as a locomotive inspector by Alfred Lovell, consulting engineer. For a short time he was employed as track foreman in the Philadelphia erecting shop of the Baldwin Locomotive Works, and in June, 1910, he became a draftsman in the office of the mechanical engineer of the Baltimore & Ohio, and was placed in charge of the design of shop tools and special appliances for shop improvements, which position he occupied until his recent appointment on the Kansas City Southern.

W. J. TOLLERTON, mechanical superintendent of the Rock Island Lines, with office at Chicago, has been appointed general mechanical superintendent of the Rock Island Lines in full charge of the mechanical department. T. Rumney, assistant second vice-president in charge of the mechanical department having resigned, his former position has been abolished. Mr. Tollerton was born in 1870, at St. Paul, Minn., and was educated in the public schools, and in high school. He began railway work as a machinist apprentice on the St. Paul & Duluth, now a part of the Northern Pacific, and after a short time became a fireman on the Omaha Railway. He went to the Union Pacific in 1890 as foreman, and afterwards was general foreman. In 1896 he was appointed master mechanic of the Utah division of the Oregon Short Line, and in 1903 was made master mechanic of the Idaho, Utah and Montana divisions of the same road, with office at Pocatello, Idaho. He went to the Rock Island in July, 1906, as superintendent of motive power in charge of lines west of the Mississippi river, with office at Topeka, Kan., and was promoted in April, 1907, to assistant general superintendent of motive power of the Rock Island Lines, with headquarters at Chicago. In May, 1912, his title was changed to mechanical superintendent.

W. J. Tollerton.

W. L. KELLOGG, superintendent of motive power of the Pere

Marquette, at Grand Rapids, Mich., has been appointed superintendent of machinery and equipment of the Missouri, Kansas & Texas, with headquarters at Parsons, Kans., succeeding William O'Herin.

W. E. Ladley, master mechanic of the Chicago & Alton, with headquarters at Bloomington, Ill., has been appointed superintendent of motive power of the Reid Newfoundland Company, with headquarters at St. John's, Newfoundland, effective January 1. He will have charge of locomotive, marine building and repairs, traveling engineers, engineers, firemen and all mechanical matters.

Fred. Mertsheimer, superintendent of motive power and car department of the Kansas City, Mexico & Orient, with office at Wichita, Kan., has resigned.

G. E. Perry, master mechanic of the Missouri, Oklahoma & Gulf, has been appointed superintendent of motive power, with headquarters at Muskogee, Okla., and the former position is abolished.

W. E. Symons has been appointed superintendent of motive power of the San Antonio & Arkansas Pass, with headquarters at San Antonio, Tex., succeeding G. W. Taylor.

J. J. Waters has been appointed superintendent of motive power of the Pere Marquette, with headquarters at Grand Rapids, Mich., to succeed W. L. Kellogg, resigned.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

F. Connolly has been appointed supervisor of locomotive operation of the Kansas City Terminal and Kansas divisions of the Rock Island Lines, with headquarters at Herington, Kan., reporting to the master mechanic at Horton, Kan. His duties will include the divisional work of locomotive operation under the direction of H. Clewer, general superintendent of locomotive operation, as mentioned in the *American Engineer* for December.

D. W. Cross has been appointed master mechanic of the Toledo, St. Louis & Western, with headquarters at Frankfort, Ind., effective January 1.

C. C. Hayman has been appointed road foreman of engines on the Middle division of the Atchison, Topeka & Santa Fe, with headquarters at Newton, Kan.

David Hopkins has been appointed road foreman of engines on the Valley division of the Atchison, Topeka & Santa Fe with jurisdiction east of Fresno and including the Sunset Railway. His headquarters will be at Fresno, Cal.

H. O. Inglish has been appointed master mechanic of the Texas City Terminal, at Texas City, Tex., succeeding F. A. Scott.

W. E. Maxfield has been appointed master mechanic of the Texas & Pacific, with office at Big Springs, Tex., succeeding C. E. Boss.

C. C. McCauley has been appointed road foreman of engines on the first district Albuquerque division of the Atchison, Topeka & Santa Fe Coast Lines, with headquarters at Albuquerque, N. M., vice C. M. Byrd, assigned to other duties.

Michael McGraw has been appointed master mechanic of the Chicago & Alton, with headquarters at Bloomington, Ill., succeeding W. E. Ladley, resigned.

F. J. Moffatt has been appointed road foreman of the Grand Trunk Pacific, with territory from Watrous, Sask., to Wainwright, Alta., including branches, succeeding C. D. Smith. He will report to J. R. Mooney, road foreman at Wainwright.

N. J. O'Connor has been appointed master mechanic of the Florence & Cripple Creek, with office at Colorado Springs, Colo.

S. T. Patterson has been appointed supervisor of locomotive operation of the Arkansas division of the Chicago, Rock Island & Pacific, with headquarters at Little Rock, Ark. He will report to the local master mechanic and will carry on the divisional work of locomotive operation under the direction of H. Clewer, as mentioned in the December issue of the *American Engineer.*

Ralph Ramsey has been appointed traveling engineer of the Texas & Pacific, with office at Marshall, Tex.

J. B. Randall has been appointed master mechanic of the Louisville, Henderson & St. Louis, and the position of assistant master mechanic has been abolished.

E. Schultz, formerly roundhouse foreman of the Chicago & Northwestern, at Milwaukee, Wis., has been appointed master mechanic of the Northern Wisconsin and Lake Shore divisions at Green Bay, Wis.

Christian F. Schraag, road foreman of equipment for the Danville district of the Chicago & Eastern Illinois, will have his jurisdiction extended over the entire Evansville division.

William C. Sealy, whose appointment as assistant master mechanic of the Middle and Southern divisions of the Grand Trunk, with headquarters at Toronto, Ont., was announced in the December, 1912, issue of the *American Engineer*, was born November 29, 1886, at Stratford, Ont., and was educated in the public schools of his native town and at the Collegiate Institute. He began railway work in September, 1902, on the Grand Trunk, and until 1907 was an apprentice. He was then for one year chargeman, and from 1908 to 1909 was erecting shop foreman. He was promoted to general foreman of the Toronto shops in 1910, which position he held at the time of his recent appointment as assistant master mechanic.

John L. Smith, acting master mechanic of the Pittsburgh, Shawmut & Northern, at St. Marys, Pa., has been appointed master mechanic, effective January 1.

J. B. Stewart has been appointed master mechanic of the Texas, Oklahoma & Gulf, with office at Bismarck, Okla.

S. G. Trussell has been appointed assistant road foreman of equipment of the Evansville division of the Chicago & Eastern Illinois.

R. E. Wallace has been appointed supervisor of locomotive operation of the Chicago Terminal and Illinois divisions of the Rock Island Lines, with office at Chicago. He will report to the master mechanic at Chicago, and will have charge of the mechanical operation of all engines on those divisions, under the direction of H. Clewer, as outlined in our December issue.

B. L. Wheatley, road foreman of equipment of the Rock Island Lines, at Valley Junction, Ia., has been appointed master mechanic of the Southern division, with office at Fort Worth, Tex., succeeding H. Clewer, promoted.

Charles Wilkie has been appointed road foreman of engines of the Pere Marquette, with office at Port Huron, Mich.

C. S. Yeaton has been appointed supervisor of locomotive operation of the Oklahoma division of the Rock Island Lines, with headquarters at El Reno, Okla., and will report to the master mechanic at Chickasha, Okla. He will be in charge of the mechanical operation of all engines in service on that division, as outlined in the *American Engineer* for December, in the announcement of the appointment of H. Clewer as superintendent of locomotive operation.

CAR DEPARTMENT

W. M. Ellis, chief car inspector of the Alabama Great Southern, at Birmingham, Ala., has been appointed general foreman car repairers at that point.

Van R. Lewis has been appointed foreman in the freight car

shops of the Texas & Pacific, at Marshall, Tex., vice G. W. Horton, resigned.

C. W. MADDOX has been appointed chief car inspector and piece work supervisor of the Chesapeake & Ohio, with office at Richmond, Va.

JOHN MCMULLEN, shop superintendent of the Erie at Buffalo, N. Y., has been appointed mechanical superintendent of the Erie and subsidiary companies in charge of the car department, with headquarters at Meadville, Pa., succeeding E. A. Wescott, assigned to other duties.

WILLIAM MILLER has been appointed superintendent of the Kent car shop of the Erie, succeeding Adam Trautman transferred.

C. S. SIMPSON has been appointed foreman of the car department of the Missouri, Kansas & Texas, at Smithville, Tex., vice S. J. Stephenson, resigned.

ADAM TRAUTMAN has been appointed superintendent of the Buffalo car shop of the Erie, succeeding John McMullen, promoted.

SHOP AND ENGINE HOUSE

J. ALEXANDER has been appointed locomotive foreman of the Canadian Pacific at Hardisty, Alta., succeeding E. B. Patterson, resigned.

A. E. BENNETT has been appointed locomotive foreman of the Canadian Pacific at Eholt, B. C.

A. W. CLARK has been appointed locomotive foreman of the Canadian Pacific at Kamloops, B. C.

B. CONLEY has been appointed night engine house foreman of the Marshall & East Texas, at Marshall, Tex., vice W. Mayes, resigned.

CARL N. FREY, piece work inspector for the Wheeling & Lake Erie, has been appointed to a similar position on the Michigan Central.

F. H. HARDESTY has been appointed foreman boilermaker of the Trinity & Brazos Valley at Teague, Tex.

G. HILFRINK, general foreman of the Pere Marquette, at Saginaw, Mich., has been promoted to the position of shop superintendent, with headquarters at the same place, succeeding W. W. Scott.

E. KENNEDY has been appointed assistant general foreman of the New York Central & Hudson River shops at West Albany, succeeding E. V. Williams, promoted.

DANIEL G. LAKING has been appointed assistant foreman of the Chicago & Eastern Illinois, at Evansville, Ind.

S. H. LEE has been appointed foreman of locomotive repairs of the Chicago, St. Paul, Minneapolis & Omaha, at East St. Paul, Minn.

W. H. LEE has been appointed locomotive foreman of the Canadian Pacific at Weyburn, Sask., succeeding P. Walz, resigned.

JOHN MCDOWELL has been appointed foreman painter of the Rock Island Lines at Cedar Rapids, Ia., succeeding B. D. Mason, resigned.

M. J. MCGRAW has resigned his position as superintendent of the Missouri Pacific shops at Sedalia, Mo., to accept a similar position with the Texas & New Orleans, at Houston, Tex.

W. F. MEADWAY, erecting foreman of the Delaware, Lackawanna & Western, at Buffalo, N. Y., has been appointed tool foreman at that point.

C. MURPHY has been appointed erecting shop foreman of the Trinity & Brazos Valley, at Teague, Tex.

T. H. NANNEY has been appointed general foreman of the Buffalo & Susquehanna, at Galeton, Pa.

M. A. O'LEARY, gang foreman for the Southern Pacific at Roseburg, has been appointed roundhouse foreman on the same road at Grant's Pass, Oregon.

S. J. PENKETH, machine foreman of the Pere Marquette at Saginaw, Mich., has been appointed erecting foreman of the Delaware, Lackawanna & Western, at Buffalo, N. Y., succeeding W. F. Meadway.

D. L. RINGLER, foreman of the erecting shop of the Trinity & Brazos Valley at Teague, Tex., has been appointed night roundhouse foreman.

W. W. SCOTT, shop superintendent of the Pere Marquette, at Saginaw, Mich., has been appointed general foreman of the Delaware, Lackawanna & Western, at Buffalo, N. Y. A sketch of Mr. Scott's career was given in the January, 1912, issue of the *American Engineer*.

E. V. WILLIAMS has been appointed general foreman of the New York Central & Hudson River shops at West Albany, succeeding T. H. Leonard, resigned.

HARRY WORKING has been appointed assistant engine house foreman of the Atchison, Topeka & Santa Fe, at Cleburne, Tex.

PURCHASING AND STOREKEEPING

F. A. BUSHNELL, purchasing agent of the Spokane, Portland & Seattle, at Portland, Ore., has been appointed assistant purchasing agent of the Great Northern, with headquarters at St. Paul, Minn.

W. G. PHELPS, chief clerk to the second vice-president of the Pennsylvania Lines West of Pittsburgh, has been appointed assistant purchasing agent, with headquarters at Pittsburgh, Pa.

The office of H. W. Davies, purchasing agent of the Norfolk Southern, at Norfolk, Va., has been abolished, and Mr. Davies has been assigned to other duties.

BOSTON EMPLOYMENT BUREAU.—The National Metal Trades Association of Boston shows that in the three months ending with September there were 1,070 applications and 509 new registrations. The number of men sent out was 455, out of which 225 were hired.

PURE DRINKING WATER.—The Chicago, Burlington & Quincy has arranged to send Dr. D. J. Evans, medical examiner for the company, over the lines of the system for the purpose of inspecting water and ice used in the passenger coaches, dining cars and station restaurants. He will also investigate the sanitary conditions along the line.

MOTOR CAR SERVICE IN BAVARIA.—In Bavaria the administration which operates the railways maintains also an automobile service on 53 routes permanently, and on eight more during the summer, carrying passengers and mail and parcels. The service has been profitable, the expenses per motor car mile being 15 cents and the earnings nearly 20 cents, and the net for all the lines amounting to $88,000.

TRESPASSERS IN TEXAS.—From a report of H. G. Askew, statistician for the Texas railways, it is shown for the year ending June 30, 1912, a total of 159 trespassers were killed and 232 were injured on 32 roads representing 90 per cent. of the total railway mileage in the state. This is an increase of 31 trespassers killed and 58 injured. The claims paid for 1912 were $2,871,496 as against $1,847,701 for the fiscal year 1908.

NEW SHOPS

Ann Arbor.—New shops and an engine house will be erected at Owosso, Mich., at an estimated cost of $300,000.

Atchison, Topeka & Santa Fe.—New shops and terminals, including car shops, engine house, boiler, machine and blacksmith shops and other buildings, will be built at Albuquerque, N. M., at an approximate cost of $1,500,000. A 36-stall engine house with shops and passenger station will be built at Gallup, N. M. A wheel shop will be added to the shop at San Bernardino, Cal., at an approximate cost of $11,000.

Boston & Maine.—The list of tools for the Billerica, Mass., shops has been published. The list requires an early delivery, so that the shop may be in operation by next July.

Canadian Northern.—New shops will be built in the vicinity of Toronto, Ont., which will employ about 300 men. It is reported that $2,000,000 will be spent for shops in the middle West, probably in Saskatoon, Sask. New terminals will be built at Port Mann, B. C., which will consist of 60 miles of freight yard tracks, extensive repair shops, a 20-stall engine house, freight sheds, and several auxiliary buildings.

Canadian Pacific.—Additions to the West Toronto, Ont., shops are under construction.

Carolina, Clinchfield & Ohio.—Large machine and car shops will be erected at Elkhorn, Ky.

Central of New Jersey.—An engine house will be built at Cranford, N. J., and plans are being considered for the construction of an engine house in Jersey City.

Chicago, Milwaukee & Puget Sound.—The plans for the improvement of the shops at Tacoma, Wash., have been completed.

Chicago, Milwaukee & St. Paul.—It is reported that the blacksmith and tank shops at Deer Lodge, Mont., will be improved and enlarged.

Chicago, Rock Island & Pacific.—A boiler house and engine house will be erected in Chicago. Bids are being received.

Cleveland, Cincinnati, Chicago & St. Louis.—Contract for a six-stall roundhouse at Cairo, Ill., has been awarded.

Cleveland, Cincinnati, Chicago & St. Louis.—It is reported that car shops will be erected at Bellefontaine, Ohio.

Elgin, Joliet & Eastern.—Work has been started on the locomotive shops at East Joliet, Ill.

Illinois Central.—It is reported that the shops at East St. Louis, Ill., will be enlarged.

Michigan Central.—Large additions to the shops at Detroit, Mich., will soon be made.

Oregon Short Line.—The car shops at Pocatello, Idaho, which were destroyed by fire a few weeks ago are being rebuilt. The shops will also be enlarged in the spring. A four-stall engine house will be built at Flatfoot, Idaho.

Pittsburgh & Lake Erie.—Bids have been received for the erection of the new shop at McKees Rocks, Pa.

Pittsburgh, Ft. Wayne & Chicago.—The machine shop at Ft. Wayne, Ind., is being remodeled and enlarged.

Southern Pacific.—It is reported that new shops will be erected at Newark, Cal.

St. Louis, Brownsville & Mexico.—A repair shop is being built at Kingsville, Tex.

Texas & Pacific.—A site has been purchased in New Orleans, La., for terminal facilities.

SUPPLY TRADE NOTES

Marvin F. Wood, general sales manager of the Van Nest Company, New York, has resigned.

The name of the Dearborn Drug & Chemical Works has been changed to Dearborn Chemical Company.

The offices of Clement F. Street, Schenectady, N. Y., have been moved to 30 Church street, New York.

H. T. Armstrong has been placed in charge of a branch office of the Davenport Locomotive Works in the First National Bank building, Cincinnati, Ohio.

The Pullman Company will raise the salaries of its clerical force January 1 by amounts ranging from two to 12 per cent. The increase will amount to $300,000 per year.

The Oxweld Acetylene Company removed its general office in Chicago on December 16, from the Peoples Gas building, to its new works at Thirty-sixth street and Jasper place.

A. B. Chadwick, superintendent of the Armour car shops, Meridian, Miss., has resigned to become manager of the shops of the Grip Nut Company, Chicago, effective January 1.

L. H. Mesker, manager of the St. Louis branch of Manning, Maxwell & Moore, Inc., has resigned to take a similar position with the Ferro Machine & Foundry Co., Cleveland, Ohio.

A. E. Crone, formerly storekeeper of the New York Central & Hudson River, at Depew, N. Y., has been made supply agent of the Buffalo Brake Beam Company, Buffalo, N. Y., with office in that city.

The Western Electric Company, Chicago, has declared an extra dividend of $2 on its common stock in addition to the regular quarterly dividend of $2 per share, payable December 31 to stock of record December 24.

H. E. Lavelle, formerly with the Standard Paint Company, has been made selling and mechanical representative of the Automatic Ventilator Company, New York, for the middle western states, with office in Indianapolis, Ind.

John J. Swan, formerly manager of the New York office of the Chicago Pneumatic Tool Company, and later mechanical engineer in the compressor department of that company, has resigned to go to the Oil Power Engineering Corporation, New York.

The Baldwin Locomotive Works, Philadelphia, Pa., report that they have a greater working force in their various plants than ever before, 19,250 employees being enrolled at the Eddystone, Lewistown and Philadelphia works. The new erecting shop at Eddystone is now in full operation.

The H. W. Johns-Manville Company, New York, has opened a branch office at 31½ South Broad street, Atlanta, Ga., in charge of C. S. Berry as manager. To facilitate delivery in the South a stock of roofings, pipe coverings and other J.-M. asbestos, magnesia and electrical products is carried at that point.

F. M. Whyte has been elected vice-president of the Hutchins Car Roofing Company, with offices in New York. Mr. Whyte for many years was general mechanical engineer of the New York Central Lines, and for the past two years has been general manager of the New York Air Brake Company.

Fred Coe Taylor, chief engineer of the Conley Frog & Switch Company, Memphis, Tenn., has resigned to go to the H. W. Johns-Manville Company, New York, as manager of its insulation department, with office in St. Louis, Mo. J. W. Buzick, assistant engineer of the Conley company, succeeds Mr. Taylor.

Henry Hess has sold his stock holdings in the Hess-Bright Manufacturing Company, Philadelphia, Pa., makers of ball bearings, to the Deutsche Waffen & Munitionsfabriken, Berlin, Ger-

many, and has resigned his position to devote himself to his other interests. The controlling ownership of the company remains in America in the hands of F. B. Bright, president.

Charles W. Beaver has been made manager of the chain block department of the Yale & Towne Manufacturing Company, New York, succeeding R. P. Hodgkins, resigned. Mr. Beaver has been connected with the chain block department of this company for a number of years, first as salesman and later as assistant manager. For the past two years he has represented the company in Europe.

The Lehon Company, Chicago, manufacturers of protective products, has just completed a large addition to its roofing and insulating mill at Forty-fifth street and Western avenue, Chicago. The output of the concern has been practically doubled by recent improvements. The company is now furnishing its Per-Bona insulating paper for the 3,000 Harriman Lines refrigerator cars recently ordered.

The Pullman Company now has approximately 12,000 men on its payroll in the manufacturing department, as compared with an average of 7,645 in the last fiscal year, of which 3,000 are working overtime. The freight car department is running at about 75 per cent. of its capacity, with orders for about 14.000 cars on the books. The passenger car department is running at nearly full capacity.

The Vandorn & Dutton Company, Cleveland, Ohio, has increased its space and facilities for the manufacture of its Hard Service portable electrically operated drills and reamers by disposing of its electric department in which armature, field and induction motor coils for motors for railway and mill service were produced. The facilities pertaining to motor repairs, armature, field and induction motor coils have been taken over by the Cleveland Coil & Manufacturing Company.

For a quarter of a century the general office and Chicago laboratories of Robert W. Hunt & Co. have been in the Rookery. Owing to inability to secure in that building the necessary space in which to conduct their very largely increased business, the offices and laboratories were moved on December 1 to the twenty-second floor of the Insurance Exchange building, Jackson boulevard, between Sherman street and Fifth avenue.

Joseph M. Brown, who has been engaged in the railway supply business under the name of Joseph M. Brown Company, has taken a partner and incorporated under the name of Brown-Lewis Railway Supply Company. The new company will continue the representation of the several companies previously handled by Mr. Brown, in addition to the high-speed tool steel of the Newman-Andrew Company, of New York, importers of the "Toledo brand" of tool steel. The latter will be handled by Mr. Brown's partner, James S. Lewis, who has been connected with the Charles G. Stevens Company, and has had many years of experience in tool steel business.

The reorganization committee of the Allis-Chalmers Company, Milwaukee, Wis., has called a third assessment of $3 on the common stock and $6 on the preferred stock. The assessment is payable January 15. There still remains to be paid $4 on the common and $8 on the preferred. The court has ordered that the foreclosure sale of the Allis-Chalmers properties take place February 3. Up to December 13 there had been deposited under the plan of reorganization $10,458,000 first mortgage 5 per cent. bonds, or 93 per cent. of the outstanding issue, $14,146,500—7 per cent. cumulative preferred stock, or 88 per cent. of the outstanding issue, and $17,215,600 of the common stock, or 86 per cent. of the outstanding issue.

W. P. Steele has been appointed assistant to the president of the American Locomotive Company and will perform the duties heretofore assigned to him in addition to such other duties as the president may direct. Mr. Steele entered the service of the Boston & Lowell, now a part of the Boston & Maine, in 1880. He occupied various positions in the shop, and in firing, running and other classes of locomotive service until 1901. For the next six years he was associated with railway supply concerns which were interested in locomotive development and in 1907 entered the engineering department of the American Locomotive Company as an assistant to the vice-president in charge of design. This position he held until the time of his appointment as noted above.

J. B. Ennis has been appointed chief mechanical engineer of the American Locomotive Company, with headquarters at New York. He will perform the duties formerly assigned to the vice-president in charge of engineering with the exception that the chief engineer will report directly to the president on construction and shop engineering matters. Mr. Ennis became identified with the engineering department of the Rogers Locomotive Works, at Paterson, N. J., in 1895. Later he was connected in a similar capacity with both the Cooke Locomotive Works, of Paterson, N. J., and the Schenectady Locomotive Works, Schenectady, N. Y. He has been connected with the engineering department of the American Locomotive Company at the New York office ever since its organization.

William Miller, president of the Monarch Pneumatic Tool Company, has resigned, effective December 31, and has accepted the vice-presidency of the Pyle-National Electric Headlight Company, with offices in the Karpen building, Chicago. Mr. Miller began his apprenticeship in the Hannibal & St. Joseph shops at Hannibal, Mo., in 1881, and in 1885 was journeyman with the Missouri, Kansas & Texas at Hannibal. He was with the Wabash at Moberly, Mo., in 1886, and the following year was employed by the Denver & Rio Grande at Denver, Colo. He became shop foreman of the St. Louis & San Francisco at Springfield, Mo., in 1889; general foreman of shops of the Colorado Midland at Colorado City, Colo., in 1900; master mechanic of the Terminal Railroad Association of St. Louis in 1904, and was appointed assistant superintendent of motive power of the Denver & Rio Grande in 1905. He went to the Western Maryland as superintendent of motive power and car department at Union Bridge, Md., in 1907, and in 1908 entered the commercial field as vice-president of the Adreon Manufacturing Company, with offices at Chicago. Mr. Miller became president of the Monarch Pneumatic Tool Company and vice-president of the Standard Railway Equipment Company in 1911.

H. F. Ball has opened an office in the Hudson Terminal building, 30 Church street, New York, as a special consulting engineer. Mr. Ball entered the service of the Pennsylvania Railroad as an apprentice at Altoona, Pa., in 1884. Four years later he entered the drafting room at Altoona, and in 1890 was appointed chief draftsman of the car department of the Lake Shore & Michigan Southern. Two years later he was placed in charge of the car shops at Cleveland, as general foreman, and in 1894 was appointed general car inspector. Five years later he was made mechanical engineer of the Lake Shore, which position he held until his promotion to the position of superintendent of motive power in February, 1902. In 1906 he left the Lake Shore to accept the vice-presidency of the American Locomotive Automobile Company; a few months later his jurisdiction was extended over the American Locomotive Company as vice-president of engineering. This position he resigned a short time ago, as announced in our issue of December, 1912. Mr. Ball's tenure of office, as vice-president of engineering of the American Locomotive Company has been coincident with some of the most important improvements made in locomotive construction, as well as the great increase in power and weight which characterize the present day locomotive. It covered such radical changes in design, as a substitution of the Walschaert for the Stephenson valve gear, the use of superheated for saturated steam, and the successful development of the Mallet locomotive. Mr. Ball was president of the Central Railway Club in 1900 and of the American Railway Master Mechanics' Association in 1905-6.

CATALOGS

Pipe Unions.—A leaflet being sent out by the Jefferson Union Company, Lexington, Mass., briefly draws attention to the fact that this company is a specialist on unions and makes nothing else. The Jefferson union is illustrated in several styles.

Power Plant Equipment.—Schutte & Koerting Company, Philadelphia, Pa., is issuing a twenty-page catalog in which various pieces of apparatus used in the power house are illustrated and briefly described. This includes injectors, condensers, various types of valves, furnace blowers, automatic eductors, oil firing system and chimney ventilators.

Coal Conveyors and Industrial Railways.—Two pamphlets have been issued on the Hunt noiseless coal conveyor and the Hunt industrial railways, by the C. W. Hunt Company, New York. They contain illustrations of the various types of coal conveyors and automatic dumpers, with a description as to their applications and a very complete description of industrial railways.

Electric Testing Laboratories.—A leaflet issued by the Electric Testing Laboratories, Eightieth street and East End avenue, New York, briefly outlines the work that this company is prepared to undertake. This includes the preparation of specifications and the inspection and testing of all kinds of electric apparatus. The tests are made either in the laboratory or at the manufacturer's works. Tests of equipment in use in any part of the country will also be undertaken.

Motors and Generators.—Adjustable speed, small sized, direct current motors in sizes from 1/3 to 32 horsepower, form the subject of bulletin No. 158 from the Crocker-Wheeler Company, Ampere, N. J. These are fully illustrated and described and several applications to machine tools are shown Bulletin No. 159 from the same company is devoted to the subject of alternating current generators of 50 k. v. a., or larger, capacity. These are designed for both two and three phase circuits and are fully illustrated.

Chucks.—The Skinner Chuck Company, New Britain, Conn., has issued a new catalog and price list which supersedes all previous publications from this company. In it is illustrated and described a complete line of independent, universal and combination lathe chucks, as well as drill chucks, planer chucks, face plate jaws, drill press vises and reamer stands. With the illustration of each style there appears a table of dimensions giving complete information on the dimensions of details for each size of chuck. A telegraphic code with a word for each size of each type of chuck is included.

Hose Coupling.—Bulletin No. 303 from the Thomas H. Dallett Company, York and Twenty-third streets, Philadelphia, Pa., is devoted to a complete illustrated description of the Dallett quick action hose coupling. This coupling is made of hard bronze with no projecting pieces to catch when the hose is trailed on the ground. It is not only designed for rapid connecting and disconnecting, but is intended especially to give a positive air tight joint under all conditions and to remain coupled in any position of the hose. Other accessories for air hose are briefly mentioned in the same catalog.

Steam Turbines.—A 48-page booklet recently issued by the De Laval Steam Turbine Company, Trenton, N. J., fully illustrates and describes the velocity stage type of turbine which is built in sizes up to 600 horse power, and is suitable for direct connection to centrifugal pumps, blowers or small generators. This booklet outlines the factors effecting the suitability of different types of turbines for different services, the methods of velocity staging for small turbines and the practical considerations of material and design. The velocity stage type turbine as built by this company has several distinguishing features. The catalog is fully illustrated.

Acetylene Generators.—A small leaflet issued by the Alexander K. Milburn Company, Baltimore, Md., briefly describes various types of acetylene gas generators to be used in connection with lighting or welding outfits. These are shown both in portable and stationary forms with lights of practically any desired candle power attached. The portable machines are entirely automatic and one type of 500 candle power size is shown as arranged for a hand light. A portable oxy-acetylene welding outfit is shown, as is also a new oxy-acetylene generator which utilizes waste steam to generate the gas. This company has manufactured over 70,000 acetylene generators.

Welding, Cutting and Brazing.—The Northwestern Blau-Gas Company, St. Paul, Minn., has issued a 40-page pamphlet illustrating and describing the ways in which Blau gas may be used for welding, cutting and brazing. Blau gas is a new gas invented by Hermann Blau, a German, and is exceptionally well adapted for welding, cutting and brazing purposes. It is a compressed liquefied distillation gas produced from mineral oils. In the process of manufacture it is reduced to 1/400 of its volume and all poisons and impurities are removed. One cubic foot of expanded gas will produce 1,800 B. t. u. Among the illustrations are shown repairs to heavy gear wheels, automobile chassis, propeller blades, crank shafts and the cutting of steel girders.

Electric Drills.—Three bulletins issued by the Chicago Pneumatic Tool Company, Fisher building, Chicago, describe the latest development in portable electric drills. One is devoted to heavy duty electric drills for alternating current, which are built in sizes ranging from ⅜ in. to 2 in. capacity. The construction and equipment of each of these is fully illustrated and described. Another bulletin is devoted to similar information on heavy duty electric drills for direct current which are furnished in sizes covering the same range. The third bulletin is devoted to drills which will operate on either direct current or single phase alternating current. These are furnished in sizes suitable for holes of from 3/16 in. to 1¼ in. diameter in metal. General specifications are given for each size.

Passenger Traffic in Japan.—The gross earnings of the Japanese railways are 55 per cent. from passengers and 45 per cent. from freight, as compared with 25 per cent. from passengers and 75 per cent. from freight in the United States.—*Erie Railroad Employees' Magazine.*

Swiss Railway Earnings.—The receipts of the Swiss state railways for 1911 were as follows: Passenger traffic, $15,001,890; freight traffic, $21,263,988; other receipts, $1,458,926, a total of $37,724,804. Expenditures were $22,664,762, making a balance in favor of the government of $15,060,042.

Physical Valuation of the Lehigh Valley.—As a result of the physical valuation on the Lehigh Valley it is shown that the company's property used for transportation is worth $300,000,000, which amounts to $159,300,000 surplus for the stockholders, or a percentage value of 236 for the shares.

Maintenance Costs on Nebraska Railways.—Engineering and superintendence on Nebraska railways cost $1,034.67 per roadway mile and $810.15 per track mile, or 2.16 per cent. of the total value of roadway, equipment, etc. These figures are from the report of the Nebraska State Railway Commission.

Engineman Imprisoned for Negligence.—In Germany, last June, an engineman overran a signal set against him and caused a collision by which three persons were killed and 28 injured, some of them severely. The criminal court at Leipsic tried him for criminal negligence and sentenced him to 15 months' imprisonment.